





The Book *of* Fishes



©CIA807650

R

COPYRIGHT 1924

BY THE NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON, D. C.
IN THE UNITED STATES AND GREAT BRITAIN

Individual Copyright 1912, 1913, 1919, 1921, 1922, 1923

Oct 31 1924
220, 2

THE BOOK *of* FISHES

Game Fishes, Food Fishes, Shellfish and Curious
Citizens *of* American Ocean Shores,
Lakes and Rivers ✓

WITH 134 ILLUSTRATIONS
COLOR PLATES OF 92 FAMILIAR SALT AND
FRESH-WATER FISHES

FISHES AND FISHERIES OF OUR NORTH ATLANTIC SEABOARD *by John Oliver La Gorce, Miami Aquarium*: OUR HERITAGE OF THE FRESH WATERS *by Charles Haskins Townsend, director of the New York Aquarium*: CERTAIN CITIZENS OF THE WARM SEA *by Louis L. Mowbray*: CURIOUS INHABITANTS OF THE GULF STREAM *by John T. Nichols, Curator of Recent Fishes, American Museum of Natural History*: DEVIL-FISHING IN THE GULF STREAM *by John Oliver La Gorce, Miami Aquarium*: SALMON: AMERICA'S MOST VALUABLE FISH *by Hugh M. Smith, Former United States Commissioner of Fisheries*: OYSTERS: A LEADING FISHERY PRODUCT *by Hugh M. Smith*: LIFE ON THE GRAND BANKS *by Frederick William Wallace*: COLOR PLATES FROM LIFE *by Hashime Murayama*.

PUBLISHED BY
THE NATIONAL GEOGRAPHIC SOCIETY
WASHINGTON, D. C., U. S. A.

1924

copy 2

FOREWORD

SINCE the earliest days of the white man's settlement in North America, when the seemingly unlimited supply of food fish taken from the waters of the Grand Banks beckoned French fishermen-explorers to American shores and the courageous Pilgrims at isolated Plymouth planted fish as fertilizer with their seed to derive sufficient crops from Mother Earth to keep alive the struggling colony of home seekers, the products of the waters of the United States have become increasingly important to the growing Nation.

These same fresh and salt water areas, in addition to being reservoirs of food, have offered unending recreation and healthy sport to people in every walk of life, young and old, because the thrill of search and contest between man and fighting fish, be it angled for with bent pin or giant hook of steel, has few equals.

The Book of Fishes, it is hoped, will be of interest and value to fisherman and layman alike because it presents an authoritative life story of the most important of the fishes to be found in American waters which are so vital a factor in the Nation's food supply.

So rich are American coastal waters, rivers and bays in variety of fishes that to describe comprehensively every known species would necessitate a dozen encyclopedic volumes, too costly for general ownership. Therefore, out of the great treasure of ichthyological material gathered by the National Geographic Society, the chapters, photographic illustrations and color plates of this volume have been selected, and the most famous fishes of the diverse regions of the country are described and pictured.

The paintings from life of ninety-two species of fishes, especially, offer means of easy identification of the fisherman's catch. These, together with the amazing biographies and life histories, derived from extensive scientific and practical study, comprise a book which will prove, it is believed, a welcome addition to your natural history library.

JOHN OLIVER LA GORCE.

WASHINGTON, D. C., 1924.

EXTENSIVE BIOGRAPHIES

of the following fishes familiar to American waters.

NAME	PAGE	NAME	PAGE
Alewife.....	60	Perch, Pike.....	109
Bass, Black.....	95	Perch, White.....	96
Bass, Calico.....	96	Perch, Yellow.....	109
Bass, Rock.....	95	Pickrel, Eastern.....	100
Bass, Sea.....	70	Pike.....	101
Bass, Striped.....	69	Pollock.....	37
Bluefish.....	70	Salmon, Atlantic.....	63
Bonito.....	71	Sauger.....	109
Bullhead.....	93	Scup.....	63
Butter-fish.....	61	Shad.....	59
Catfish, Spotted.....	93	Sheepshead.....	71
Codfish.....	38	Smelt.....	65
Crappie.....	96	Squeteague.....	69
Cusk.....	56	Squirrel Hake.....	56
Drum, Fresh-water.....	107	Sturgeon, Common.....	55
Eel.....	109	Sturgeon, Lake.....	104
Flounder, Summer.....	38	Swordfish.....	63
Flounder, Winter.....	38	Tautog.....	61
Haddock.....	38	Tilefish.....	65
Halibut.....	55	Trout, Brook.....	97
Herring.....	61	Trout, Lake.....	99
Kingfish.....	71	Trout, McCloud River Rainbow.....	100
Lobster.....	67	Tuna.....	59
Mackerel.....	59	Whitefish, Common.....	106
Mullet.....	71	Whiting.....	57
Muskellunge.....	105		

NAME	PAGE
Alewife (<i>Pomolobus pseudoharengus</i>)	47
Amber Jack (<i>Seriola dumerili</i>)	155
Angel-Fish (<i>Angelichthys isabelita</i> , <i>Pomacanthus arcuatus</i> , <i>Pomacanthus paru</i> and <i>Holacanthus tricolor</i>)	176
Atlantic Salmon (<i>Salmo salar</i>)	50
Barracuda (<i>Sphyraena barracuda</i>)	143
Black Bass, Large- and Small-mouth (<i>Micropterus salmoides</i> and <i>Micropterus dolomieu</i>) ..	112
Black Grouper (<i>Mycteroperca bonaci</i>)	146
Bluefish (<i>Pomatomus saltatrix</i>)	74
Bonefish (<i>Albula vulpes</i>)	151
Bonito (<i>Sarda sarda</i>)	74
Brook Trout (<i>Salvelinus fontinalis</i>)	116
Buffalo Trunkfish (<i>Lactophrys trigonus</i>)	179
Bullhead (<i>Ameiurus nebulosus</i>)	111
Butter-fish (<i>Poronotus triacanthus</i>)	49
Butterfly Fish (<i>Chaetodon ocellatus</i>)	177
Calico Bass (<i>Pomoxis sparoides</i>)	114
Catfish (<i>Ictalurus punctatus</i>)	111
Codfish (<i>Gadus callarias</i>)	39
Cowfish (<i>Lactophrys tricornis</i>)	179
Cow Pilot (<i>Abudefduf saxatilis</i>)	182
Crappie (<i>Pomoxis annularis</i>)	114
Crawfish (<i>Panulirus argus</i>)	153
Cuckold (<i>Lactophrys triqueter</i>)	179
Cusk (<i>Brosmius brosme</i>)	43
Dolphin (<i>Coryphaena hippurus</i>)	150
Drum, Fresh-water (<i>Aplodinotus grunniens</i>) ..	123
Eel (<i>Anguilla rostrata</i>)	126
Flounder, Summer (<i>Paralichthys dentatus</i>)	40
Flounder, Winter (<i>Pseudopleuronectes americanus</i>)	40
Four-eyed Fish (<i>Chaetodon capistratus</i>)	177
Gag (<i>Mycteroperca microlepis</i>)	146
Grunt (<i>Haemulon sciurus</i>)	181
Haddock (<i>Melanogrammus aeglefinus</i>)	39
Halibut (<i>Hippoglossus hippoglossus</i>)	41
Herring (<i>Clupea harengus</i>)	47
Kingfish (<i>Menticirrhus saxatilis</i>)	76
Kingfish (<i>Scomberomorus regalis</i>)	149
Lake Trout (<i>Cristivomer namaycush</i>)	117
Lobster, American (<i>Homarus americanus</i>)	54
Mackerel (<i>Scomber scombrus</i>)	44
Margate Fish (<i>Haemulon album</i>)	148
Marlin (<i>Tetrapturus imperator</i>)	157
Moon Fish (<i>Selene vomer</i>)	147
Moray (<i>Lycodontis funebris</i>)	177
Muskellunge (<i>Esox ohiensis</i>)	121
Mullet (<i>Mugil cephalus</i>)	75
Mutton Fish (<i>Lutianus analis</i>)	144
Nassau Grouper (<i>Epinephelus striatus</i>)	145

NAME	PAGE
Octopus (<i>Octopus americanus</i>)	156
Parrot-Fish (<i>Pseudoscarus guacamaia</i>)	182
Pickerel, Eastern (<i>Esox reticulatus</i>)	119
Pike (<i>Esox lucius</i>)	119
Pike-Perch (<i>Stizostedion vitreum</i>)	125
Pollock (<i>Pollachius virens</i>)	39
Pork Fish (<i>Anisotremus virginicus</i>)	175
Portuguese Man-o'-War (<i>Physalia arethusa</i>) ..	178
Queen Trigger-fish (<i>Balistes vetula</i>)	179
Rainbow Trout (<i>Salmo irideus shasta</i>)	118
Red Grouper (<i>Epinephelus morio</i>)	145
Rock Bass (<i>Ambloplites rupestris</i>)	113
Rock Hind (<i>Epinephelus adscensionis</i>)	180
Runner (<i>Caranx ruber</i>)	155
Sailfish (<i>Istiophorus nigricans</i>)	154
Sauger (<i>Stizostedion canadense</i>)	125
Scup (<i>Stenotomus chrysops</i>)	49
Sea Bass (<i>Centropristes striatus</i>)	73
Sea Horse (<i>Hippocampus</i>)	178
Sergeant Major (<i>Abudefduf saxatilis</i>)	182
Shad (<i>Alosa sapidissima</i>)	46
Shark Sucker (<i>Echeneis naucrates</i>)	180
Sheepshead (<i>Archosargus probatocephalus</i>)	75
Silver King (<i>Tarpon atlanticus</i>)	152
Smelt (<i>Osmerus mordax</i>)	52
Soldato (<i>Holocentrus ascensionis</i>)	175
Spade Fish (<i>Chaetodipterus faber</i>)	176
Spanish Mackerel (<i>Scomberomorus maculatus</i>)	149
Spearfish (<i>Tetrapturus imperator</i>)	157
Spiny Lobster (<i>Panulirus argus</i>)	153
Squeteague (<i>Cynoscion regalis</i>)	72
Squirrel Fish (<i>Holocentrus ascensionis</i>)	175
Squirrel Hake (<i>Urophycis chuss</i>)	43
Striped Bass (<i>Roccus lineatus</i>)	72
Sturgeon (<i>Acipenser sturio</i>)	42
Sturgeon, Lake (<i>Acipenser rubicundus</i>)	120
Swordfish (<i>Xiphias gladius</i>)	51
Tarpon (<i>Tarpon atlanticus</i>)	152
Tautog (<i>Tautoga onitis</i>)	48
Tilefish (<i>Lopholatilus chamaeleonticeps</i>)	53
Tuna (<i>Thunnus thynnus</i>)	45
Turtle, Green (<i>Chelonia mydas</i>)	158
Turtle, Hawksbill (<i>Eretmochelys imbricata</i>) ..	158
Whitefish (<i>Coregonus clupeiformis</i>)	122
White Angel (<i>Chaetodipterus faber</i>)	176
White Perch (<i>Morone americana</i>)	115
Whiting (<i>Merluccius bilinearis</i>)	43
Yellow Jack (<i>Caranx ruber</i>)	155
Yellow Perch (<i>Perca flavescens</i>)	124
Yellow Tail (<i>Ocyurus chrysurus</i>)	181



Photograph by H. Armstrong Roberts

SURF FISHING ON THE ATLANTIC COAST

Fishes and Fisheries of Our North Atlantic Seaboard

By JOHN OLIVER LA GORCE
Vice President of the National Geographic Society

THE story of the fishes and fisheries of the North Atlantic seaboard of the United States is one that has the fascination of a romance.

Whether we consider the biology of the species which are the prizes of the fishing fleets, the methods of reaping this harvest of the seas, or the stern battle against the depletion of the supply, there are stirring chapters at every turn.

The world annually levies a tribute upon the seven seas of half a billion dollars' worth of fish, of which Europe collects approximately half, the United States nearly a third, and the remainder of mankind the other sixth.

In terms of weight, the portion collected by the United States amounts to 2,600,000,000 pounds, including shellfish. Three-fourths of this annual harvest reaches the markets in fresh condition; the remainder goes to the consumer as canned, salted, and smoked fish.

The North Atlantic fisheries of the American seaboard reach from the Newfoundland Banks to the Delaware River, and represent the major sea fisheries of the Atlantic coast, producing some seven hundred million pounds of sea food annually.

Considering the fisheries of the United States in these waters, one finds upward of fifty different kinds of fish and shellfish called for by fish-eating citizens, helping to swell the total annual catch. Eighteen kinds have more than two million pounds each to their credit in the national larder.

Biologically, perhaps the most interesting of all the species that figure in the returns are the Flatfish—Flounders and Halibuts—with their changing forms and

migrating eyes. By what strange quirk of Nature the left eyes of species inhabiting cold water usually migrate to the right side of their heads, while the right eyes of most species inhabiting warm water journey over to the left, no scientist will venture a guess (see Color Plate, page 41).

When they are hatched, all Flatfish are of orthodox symmetrical shape, with conventionally placed mouths and eyes, but after they swim around in ordinary fashion for a little while, they exhibit a tendency to turn to the one side or the other.

Immediately after this peculiar tendency begins to develop, the eye on the lower side seems to acquire a wanderlust. Stephen R. Williams, who studied this change, says that the optic nerves are so placed in the youngling as to provide for the migration.

THE ORIGIN OF FLATFISH

The first sign of the transformation is a rapid change in the cartilage bar lying in the path of the eye that is to migrate. Then comes an increase of the distance between the eye and the brain, caused by the growth of facial cartilages. In the Winter Flounder, three-fourths of the 120-degree migration takes place in three days. What if that should become a human habit!

The extent of the eye migration and of the flatness of the species is closely related to its habits. The Sole and the shore Flounder, which keep close to the bottom, are more twisted than the Halibut, the Sand Dab, and the Summer Flounder, which are more given to free swimming.

How this deviation from the conventional bilateral shape arose is a mystery.



A NOVA SCOTIA FISHERMAN HAULING IN HIS NET

As pressure on the world's food supply of every kind increases, knowledge of the migration, feeding, and breeding habits of fish is essential to the formulation of intelligent fisheries legislation in order to conserve the abundance of the ocean's supply of this palatable and nourishing food.



Photograph by International Newsreel

THE "SACRED CODFISH" IN THE BOSTON STATE HOUSE

In the new Hall of Representatives, in Boston, hangs a wooden Codfish "as a memorial of the importance of the Cod Fishery to the welfare of this Commonwealth," in accordance with a resolution passed in 1784. It may be seen above the transom of the door. Next to the Herring, the Cod is the world's most important economic fish, and the Cod fisheries of the Newfoundland Banks are the oldest in North America. Georges Bank, southeast of Gloucester, also is a favorite fishing ground.

Whether there came a "sport" in the family tree at some stage of its history, or whether the deviation grew from a gradual modification of the adults under the influence of their environment, cannot be said. If it came from the latter, selection naturally favored its appearance earlier and earlier in the development of the fish, until it reached the larval stage. Earlier transformation would be disad-

vantageous, since there is a lack of plankton—that imperative, if almost microscopic, food supply of the newly hatched—at the sea bottom, and the transformed fishlings would find a scarcity of provender at a critical period in their lives.

It has been noted that many transformations do occur even in the egg; but the precocious youngsters thus hatched have less chance to survive, and hence are less



Photograph by H. Armstrong Roberts

HAULING NETS DOWN TO THE SEA

Though America's total fish crop, according to recent figures, amounts to 2,600,000,000 pounds, we probably eat less fish than any other country of the world—only 24 pounds a year per capita as against 60 to 70 pounds in Europe. The United States Bureau of Fisheries has performed valuable service not only in inducing the public to eat more fish, but also in popularizing new varieties.

able to transmit to the future the tendency to earlier change.

THE ANADROMOUS FISHES

Some species that help constitute the fisheries of the North Atlantic are anadromous—that is, they spend most of their lives in the sea, but come into fresh water to spawn. Among these are the Salmon, the Shad, the Alewife, the Sturgeon, and the Striped Bass. On the Pacific coast the most striking instance of this is the Chinook Salmon, which ascends the Columbia River for a thousand miles, and the Yukon for two thousand, to find its spawning ground.

How acute this instinct has become is shown by a Canadian experiment. Salmon were accustomed to run up the Nicola River to spawn, and at one place they passed an island in midstream. It was noted that they always took one channel around this island and neglected the other. So a dam was built across the channel they were accustomed to use and the other was left open.

At the next run, when the fish approached the barrier across the channel their ancestors had used in passing the island, not a single one of them would take the other channel. They all turned back instead.

THE EELS' SPAWNING HABITS

Sometimes anadromous fishes, wandering up rivers, get into landlocked lakes. Usually they do not prosper, but die out in their new environment. It often happens, however, that such anadromous fishes as the Branch Herring and the Salmon, getting into waters out of which they are unable to find their way, so change their habits in the course of time that variations from their ancestors set in, which mark the beginnings of the formation of new species.

Other fishes of commercial importance in North Atlantic waters have habits of spawning directly opposite to the anadromous species, and they are called catadromous fishes. The true Eel is the most striking example of this class of fish.

Until recently, the location of its spawning ground was an unsolved mystery of the sea. Finally a Danish expedition succeeded in locating it in the region between Bermuda and the Leeward Islands, where the water reaches the depth of a mile.

Although they are so nearly alike that the layman cannot recognize the difference between them, and although their breeding grounds partially overlap, the European and American species neither cross nor visit one another's shores.

The eggs are laid at depths of about 650 feet and the larvæ continue to rise toward the surface as they grow. At this stage, and until they reach their respective shores, they are mere bits of ribbon, so transparent that the vertebræ of their backbones may be counted without difficulty. The only difference yet found between the European and American species is that the European has a few more vertebræ.

EELS AT THE PARTING OF THE WAYS

Both species start out, mayhap together, over a route neither has traveled before. But when they come to the parting of the ways the European Elver, with a three years' journey ahead of it, says good-bye to its American cousin, which has only a year's swim to get to its future home. By what means this unerring homing instinct is transferred from the parents, which never return, to the offsprings, that must travel a road they have never been over, is a mystery that will probably long await a solution.

The spawning habits of fishes differ as greatly in other respects as in those just mentioned. Some eggs are laid at the surface and left to their fate, with no responsibilities of any kind for the parents; others are heavy enough to sink to the bottom. Some fishes, like the King Salmon, lay their eggs on the stream bed, and the male covers them with gravel, after which male and female drift helplessly down the stream, tail first, and die.

THE LUMPFISH A DEVOTED GUARDIAN

Some species, like the Sticklebacks and the Lumpfish, guard their eggs until they are hatched. The courage and devotion of the male Lumpfish to his task has often been noted. He eats nothing while guarding the eggs, but constantly fans the egg mass to keep it free from silt and bathed in flowing water. He never deserts his post save to drive away some intruder, and finally, when the eggs are hatched, he is a picture of exhaustion and hunger.

The males of other species, including some of the common Catfishes, carry the eggs in their mouths until they hatch.



International Newsreel

BLESSING THE FISH OF THE SEA

A special service was held at St. Dunstan's, London, when the fish and market produce from the salesmen of Billingsgate and Leadenhall markets were blessed.



PREHISTORIC FISH

When a fish dies it leaves no friends. The flesh is soon devoured, the gelatinous substance of the bones decays and leaves the phosphate of lime content to be absorbed by water. Hence comparatively few geologic traces of fish remain.

The females of still other species, following the example of the Lobster, glue their eggs to the undersurface of their bodies. The male Sea Horse opens up a little pocket beneath its body, takes in the eggs from its mate, and carries them in the tiny pouch Nature provided until they hatch. Hundreds of perfectly formed Sea Horses are thus liberated at a hatching, so tiny in size the human eye can hardly distinguish them, yet perfectly formed.

Not all fishes are oviparous. Some are viviparous, such as most Sharks, the Sawfishes, the Rosefishes, the Rockfishes, the Surf Fishes, and many species of top minnows.

The number of eggs laid varies widely in different species. Scientific census-takers of Uncle Sam report that the Herring lays about 25,000, the Sturgeon about 635,000, the Halibut as many as 3,500,000, while the Cod has been known to lay more than 9,000,000.

One can gauge the perils through which the various species of fish pass from the egg state to maturity by the number of eggs they spawn. It is demonstrable

mathematically that if all the eggs of a single female Herring were to produce similarly productive generations, in ten years the oceans would be overflowing with Herring, and all the other creatures of the sea literally would be crowded out of existence.

ENEMIES OF FISHES

Indeed, it has been proved that, if only three eggs from each female of each species should develop into adult fish similarly productive, fish life would multiply so rapidly that the seas would soon become vastly overcrowded. What does happen is that less than one egg in two million in the Cod produces a reproducing Cod, and even in the Herring less than one in ten thousand successfully runs the gamut of existence. Hard, indeed, would be the road of life insurance companies of the fish world!

In this connection it is interesting to note that Nature's need for females in many species exceeds the requirement for males. In the case of the Conger Eel, the ratio is nineteen females to every



Photograph from U. S. Bureau of Fisheries

THE GENTLE ART OF TAGGING FISH

Government scientists have been doing noteworthy work in investigating the life habits of migratory food fishes by taking thousands of them, placing identification tags on their tails, and then liberating them. Wet gloves are worn by the experts during the operations because dry hands remove the glutinous veil from the scales of the fishes and expose them to the attacks of many forms of parasites.

male, and in that of the Herring, three females to every male.

The perils fish have to face are innumerable. Huxley estimates that only 5 per cent of the Herring destroyed annually by all Herring enemies in the world find their fate at the hands of man.

The other 95 per cent are the victims of whales, the porpoise family, seals, and other mammals; Cod, Haddock, Mackerel, Sharks, and other fishes; gulls, gannets, and other birds; and the thousand and one other enemies that lurk in their wake at every stage, from the newly spawned egg to the adult fish.

MANKIND, AN ASSOCIATION OF HERRING CATCHERS

How tremendous this toll of the other-than-man enemies of the Herring actually is may be gathered from the statement that man himself is credited with an annual catch of nearly eleven billion Herring. On that basis we must conclude that over two hundred billion Herring annually fall victims to their enemies in the sea—enough to load a solid fish

train reaching around the earth at the Equator.

Huxley has called mankind an association of Herring catchers, and if those fish be counted that are caught by fish which feed on them and in turn feed us, he probably has not missed the mark much.

He also reminds us that single schools covering half a dozen square miles may contain more than three billion Herring; yet many schools have been recorded that covered an area of 20 square miles.

The migration of fishes forms one of the most fascinating romances of the sea. We have seen how the Shad, the Salmon, and other species spend their adult lives in the sea and seek fresh water in which to spawn; how others, such as the Eels, spend their lives in rivers and lakes and seek salt water at spawning time.

The Mackerel and the Flying Fish families wander wide from their usual haunts at spawning time. Other species follow the great schools of Menhaden about the seas, "a full dinner pail" being the first consideration in their lives as in ours.

However, for the most part, keeping a



Photograph from Ewing Galloway

DRYING FISH AT DIGBY, NOVA SCOTIA

When fish is dried in the open air, it sometimes must be protected from sunburn by canvas awnings, and from rain at night by coops. Although fish is also dried in some factories in large steam-heated shelf driers, this method tends to be too rapid, so that the fish is dried only on the surface, instead of uniformly throughout.

complete check on the movement of the fishes of the seas is a problem still awaiting solution. The exact winter home of the common Mackerel is unknown, though a few have been caught with Cod lines in deep water off Grand Manan, and others have been taken from the stomachs of Cod on Georges and La Have Banks, as well as off the coast of New Jersey.

For a long time it was supposed that the Hickory Shad spawned in Chesapeake Bay, but investigations in that region from 1912 to 1922 failed to reveal a single member of the species under six inches long present in those waters. Its spawning grounds have not been located.

TAGS TO TELL THEIR STORIES

Likewise, the spawning grounds of the Red Tunny have never been discovered. This fish has successfully eluded every effort to trace its tracks through the deep seas.

So, also, it is with the Squeteague, or Weakfish. Appearing in Chesapeake and

Delaware Bay waters in April, and in Buzzards Bay in May, they stay until October, but where they go then is still a secret of their own.

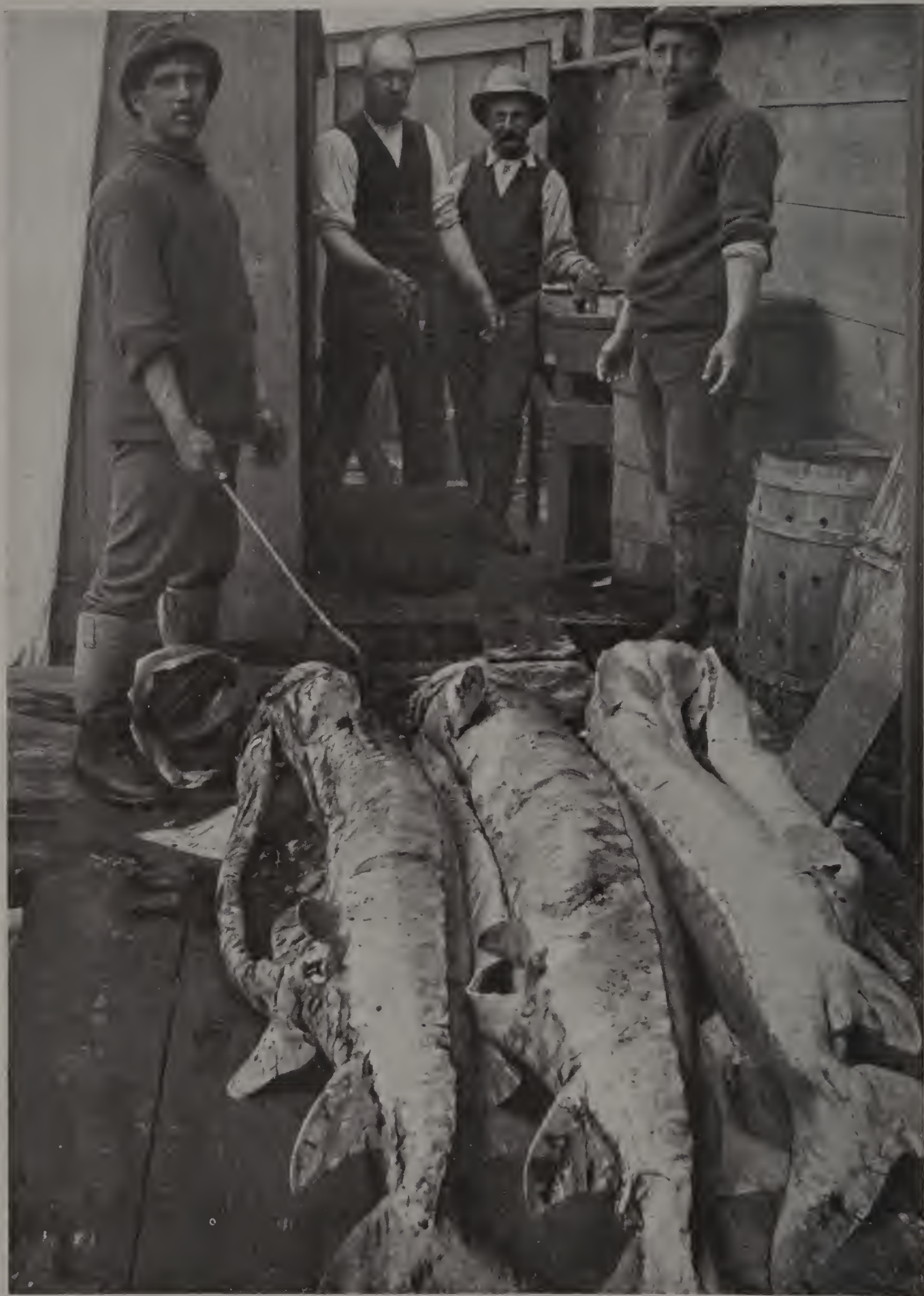
The migratory movements of Herring are so complex that, although ichthyologists have been trying to fathom the mystery for many years, a complete solution has not yet been found.

During a recent summer the United States Bureau of Fisheries decided to make a careful study of the migrations of the Cod, the Pollock, and the Haddock.

It has been tagging 10,000 of these fish—about 75 per cent Cod, 20 per cent Pollock, and 5 per cent Haddock—and turning them loose, in the hope that the fishermen of the waters they inhabit will return the tags of those caught, with information about the locality in which they were taken, a record of the date, and of their size.

For each tag returned, the fisherman receives 25 cents and the thanks of the Bureau of Fisheries.

In the tagging operations the fish are



© Underwood and Underwood

STURGEONS TAKEN FROM THE DELAWARE RIVER, NEW JERSEY

The Sturgeon fishery has been so intense as to make the taking of these fine fish to-day a comparatively rare occurrence. The largest one taken this year measured 10 feet 3 inches long, weighed 450 pounds before being dressed, and yielded 103 pounds of roe. With the meat selling for 50 cents a pound and the roe for \$2.75, the fish brought \$350.

caught with hook and line at a depth of not more than 20 fathoms. The uninjured fish is laid on a wet board, measured, and its exact length recorded. A metal tag stamped U. S. B. F. is then securely attached to the upper part of the tail, near the base, and the fish is released after a record is made of its number, its size, where released, etc. It is confidently expected that many fishermen will go to the trouble of assisting the Government by reporting to Washington when such fish are taken.

A study of the anatomy of fishes and the evolution of some of their organs throws an interesting light on life in the ocean.

WHY FISH HAVE SPHERICAL EYES

In order to see under the water, the eyes of the fish had to be constructed on lines differing somewhat from those of man and land animals. Cutting open a fish's eye, one discovers that the crystalline lens is almost a perfect sphere instead of the somewhat flattened lens of land animals. This arrangement is necessary to sight in the water, since the difference in density between the lens and the water is so slight. The result is that fish are extremely nearsighted.

The fish's power of hearing is decidedly muffled, and it is believed that what we know as the ears are solely organs of equilibration, as they partially are in man.

The sense of taste appears to be largely wanting in fish. Their tongues are without power of motion and lack delicate



A FEMALE LOBSTER "IN BERRY"

The number of eggs produced by a female Lobster varies from 3,000 to 75,000, according to its size and age. They are glued to the under-surface of her body, and carried around for about ten months before hatching (see text, page 21).

membranes. They swallow their food very rapidly and usually without mastication, further than getting it small enough to gulp it down.

FISH, LIKE MEN, LIVE ON AIR

Air dissolved in water offers fish what little oxygen they need, and the oversupply they get when out of water is fatal to most species, though some, like the Catfishes, can live for a considerable time out of their native element. A man uses thousands of times as much oxygen as a fish.

The air bladders or swim bladders of



PREPARING HERRING TO BE SMOKED: LOCKEPORT, NOVA SCOTIA

No fish contributes so largely to the support of the human race as the common Herring. It is so important and abundant in the fisheries that it is often called "King Herring." It swims closely packed, in enormous schools, often over areas of 6 to 20 square miles, and the annual catch in American and European waters is nearly two billion pounds. In Maine, quantities of young Herring are canned as sardines. One authority has estimated the annual destruction of Herring by man as upward of eleven billion fish, or seven fish to each person in the world.



CANNING LOBSTER MEAT

The Lobster forms the principal means of livelihood in many New England communities and supports a fishery from Labrador to Delaware. The toothsome-ness of the American variety was early recognized, and a regular fishery has existed on the Massachusetts coast for nearly a century. The fishing grounds are being depleted rapidly, the size and number of Lobsters caught are diminishing; hence the center of the fishery has shifted northward, first to Maine and then to the Canadian provinces.

fishes help them to solve their respective problems of hydrostatics admirably. Bottom fishes have small ones and species that range between the surface and the bottom have relatively large ones. The gas with which air bladders are filled is secreted from the blood in most species.

FROM LUNG TO AIR BLADDER

The evolution of the air bladder from a lung and the perfection of the gills to a point where they furnish oxygen enough, and therefore render lungs useless, may be traced in species still existing. In more primitive fishes the air bladder has a tube connecting it with the throat, and instead of being an empty, gas-filled, sealed sac, it is a true lung, made up of many lobes and parts and lined with a network of small blood vessels. The Gar Pike has a lunglike air bladder, and gulps air from the surface of the water. As the oxygen-assimilating gills develop in going up the scale of fish evolution, the air bladder becomes more a float and less a lung, until the latter use entirely disappears.

The major fins of fishes correspond strikingly to the limbs of land mammals. Those back of the gills are known as the pectoral fins and correspond to the arms of humans. If the bones to which they are attached are examined critically, they will be found somewhat similar to the shoulder girdle of land mammals.

Below the pectoral fins are the ventral fins, which correspond to the hind legs of quadrupeds. The dorsal fin on the back, the caudal fin at the root of the tail, and the anal fin beneath the body are used to maintain equilibrium or direction.

NATURE'S BREEDING METHODS

Nowhere is the art of camouflage more strikingly employed than in marine life. The master breeder of the ages, Nature, has provided certain, if very slow, methods of eliminating the unfit from reproduction.

One method is by tests of brute strength, as in the battles of bull seals; another is by the elimination of the slug-gards, as in the pursuit of the Herring



© H. Armstrong Roberts

AN ATLANTIC FISHERMAN MENDING HIS NETS

The gear with which the ocean fishermen comb the seas for food for man is of many kinds and of diverse types. The capital invested in the fishing fleets of the North Atlantic is in the neighborhood of \$100,000,000.



THE SOURCE OF CAVIAR

The picture shows Russians taking the fish eggs for making this famous delicacy.

by the Mackerel. A thousand and one methods are available.

None is more nearly certain among fishes than that which removes those failing to make proper use of the art of camouflage. Note the hues of a Herring in the color section (see Color Plate, page 47). Its back corresponds to the shades of the water in which it thrives; viewed from the air, it has low visibility. Its belly corresponds to the appearance of water when viewed from beneath the surface. The fishes best protected by their camouflage escape their enemies most frequently, and therefore have a better chance to reproduce. The ones that are least protected fall victims more easily, and therefore are less likely to reproduce.

USING THE ART OF CAMOUFLAGE

So, even if ever so little in each generation, the process goes on—ever the better fitting each and every thing that reproduces life to the environment in which its fortunes are cast.

The Flounder, the Halibut, or the Sand Dab, lying on the sand, has harmonizing blotches imprinted all over the upper part of its body, imitating the various kinds of sand on which it lies, whether that be

common brown sand, crushed coral, or rotting lava. The least successfully camouflaged individuals face the greatest peril and the most successfully concealed ones enjoy the greatest safety.

Man's successes in breeding horns off the ox, the long nose off the wild boar, and great size into draft horses, are but a few passing examples of throwing Nature's processes into high gear and hastening the transformation. He has done less in this respect with the fishes than with almost any other form of life, for the reason that he has had less control over them.

But, even at that, he has been able to breed pugnacity into fishes, as witness the fighting fish of Siam, where the natives have fishfights as exciting to them as are cockfights to the masses in Spanish America.

While not a fish, the Lobster, belonging to the crustacean group of animals, supports one of the most interesting and important fisheries of the American shores of the North Atlantic.

The Lobster, biologically, is a closer relative of the spider than of the fish, and the problem of saving the Lobster fisheries from utter depletion is one of the most difficult with which the fish culturists have to deal.



Photograph by Arnold L. Belcher

PART OF THE FISHING FLEET AT ANCHOR NEAR THE CUSTOMHOUSE TOWER,
BOSTON, MASSACHUSETTS

The American Lobster (see Color Plate, page 54) is found only on the eastern coast of the United States. Its known range covers a strip of the North Atlantic reaching from Labrador to North Carolina, with the Maine and lower Canadian shores as the region of its greatest commercial abundance. This strip of water is from 30 to 50 miles wide and from 6 to 600 feet deep.

THE LOBSTER'S HABITS

From the close of its early free pelagic life to its old age, which often stretches into decades, the Lobster never leaves the

sea bottom of its own accord. Its external world is the ocean floor, and it is content to stay there.

Having considerable power of locomotion, it wanders around as winter approaches, from the shallow inshore waters to the deeper ones of the 100-fathom line, searching for water of comfortable temperature and for suitable food, and attending to the duties of reproduction.

Its instincts constantly lead it to conceal itself, sometimes to take its prey unawares, and at others to hide from its natural enemies.

It walks over the sea floor on its slender



Photograph by Press Illustrating Service

CLEANING FISH IN QUAIN ST. JOHN'S, NEWFOUNDLAND

Many men spend practically their entire lives as fish cleaners. Even in so humble a trade rivalries crop out, and there are a number of claimants for the international championship in fish dressing.

legs, which are provided with brushes of sensitive hairs. With its large claws put forward to offer little resistance to the water, it keeps its "feelers" waving back and forth continually to detect danger as well as to discover game its eyes may have overlooked.

SCAVENGER OF THE SEA-FLOOR

The buoyancy of the water makes the Lobster light on its feet in its native environment, but its body weight is too great for its legs when out of water.

Though a great scavenger and tending to be nocturnal in its search for food, it is believed that the Lobster prefers fresh

food whenever that is available. Fresh Codfish heads, Flatfish, Sculpins, Sea Robins, Menhadens, and Haddocks make excellent bait, but balls of putrid, slack-salted Herring seem just as attractive.

When hungry, the big crustacean will burrow in the sand like a ravenous pig rooting for grubs, and it has been known to attack even a full-sized Conch, breaking its shell away, piece by piece, and gluttonously devouring the soft parts.

The Lobster is a cannibal by nature, preying on its weaker brethren, and did not the conditions under which it is hatched favor its immediate and wide dispersion, it would largely exterminate itself.



HANDLING TUNA: ST. MARGARETS BAY, NOVA SCOTIA

A giant fish being hoisted from the spiller net after it had been killed. Specially constructed boats are used because of the great weights of the Tuna. Before the kill great care must be used in handling it since its wide, sinewy, V-shaped tail could crush or capsize a boat.

Like dogs, Lobsters have frequently been observed to drag dead prey to some secret spot, bury it, and then mount guard over the cache, ready to defend it against all comers. And often many grim battles are fought over such caches. Indeed, few of the giant Lobsters that have been taken are without numerous scars that tell in no uncertain language of pitiless struggles to which they have been party, where quarter was neither asked nor given.

In the American Museum of Natural History in New York a giant Lobster is preserved whose living weight was 34 pounds. It was captured at Atlantic Highlands in 1897. The Smithsonian Institution has one whose living weight is estimated at 25 pounds.

Dr. F. H. Herrick, the author of the United States Bureau of Fisheries' striking study of the American Lobster, thinks that all of the thirteen titans he lists as weighing more than 20 pounds were not giants by nature, but rather simple favorites of fate, which allowed them to live to a riper age than their smaller fellow-creatures. Good luck never deserted them until they became stranded on some inhospitable beach or entangled in some fisherman's gear. Such Lobsters as these, he believes, have weathered the perils of at least half a century.

THE MOLTS OF THE LOBSTER

Few living creatures have such striking habits of changing their clothes as the Lobster. It begins to molt or discard its outgrown clothes the second day after hatching, and continues to do so with decreasing frequency until it has ceased to grow at all.

Nowhere else in Nature is the molting process so striking, so critical, or so abrupt.

When the old shell becomes too small a new skin begins to grow underneath it. When this growth nears completion the Lobster becomes a "shedder," ready to cast off not only its old shell, but even the lining of its esophagus, stomach, and intestine.

Specimens under careful observation have been found to be restless and uneasy as the time of the molt approaches. Suddenly there comes a break where the tail joins the shell. The Lobster then turns over on its side, bends itself in the

shape of a "V," with the break at the apex. Pressure is applied, and gradually the rear end of the shell breaks loose from the new one beneath.

"WIRE PULLING" A CLAW

Step by step the process of liberating the imprisoned body from its outgrown armor sweeps forward until finally the claws are withdrawn through the narrow openings. Presently, with a mighty effort, the Lobster emerges from its old coat of mail, casts off the linings of its digestive tract, and steps out, full-panoplied in a soft new shell.

The area of a cross section of the flesh in the largest part of one of its big claws is four times greater than that of a cross section of the second joint, through which it must be drawn. The process, therefore, reminds one of pulling wire through the holes of a drawplate.

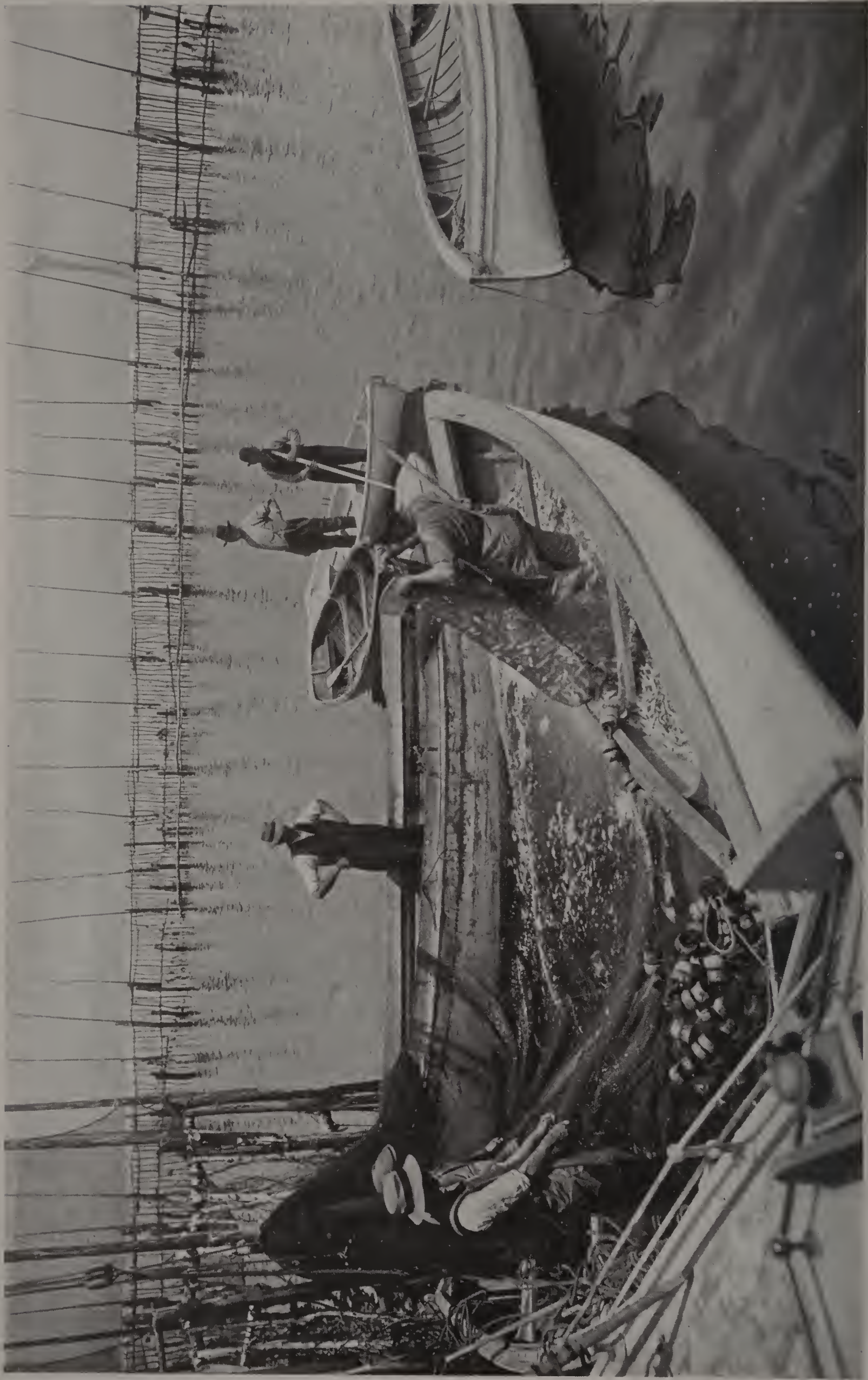
From six weeks to three months are required for the soft-shelled Lobster to become a hard-shelled one again.

The Lobster has many enemies, but, next to man and his alluring traps, the Codfish ranks as its worst foe. With an appetite that doesn't stop at a hard shell up to eight inches, and with a particular taste for young Lobsters from two to four inches in size, the Codfish is a tremendous competitor of the Lobster palace.

During their younger lives, Lobsters play into the hands of millions of foes in the sea, for it is not until the fourth or fifth stage that they leave the surface for the bottom. It is not until this period that caution seems to dawn in them and guide them to hiding places on the sea floor. In this care-free period vast schools of surface-feeding fish strain the water through which they chance to pass as effectively as might a towed net.

MESSMATES PRESENT THEMSELVES

Though only a few parasites of the Lobster are known, it has many messmates. Barnacles affix themselves to its shell and cement their tentlike coverings thereon; various kinds of Mussels insinuate themselves into attractive depressions in the carapace and joints. *Tunicata* sometimes fasten themselves on the undersurface of the body, between the legs. Tube-forming *Annelida*, lacelike *Bryozoa*, and various forms of *algæ* make



LOADING SARDINES FROM A WEIR TRAP INTO BOATS: NEW BRUNSWICK

Though fish are not commonly regarded as meat, there is no characteristic difference between fish flesh and that of animals. Protein and water form the bulk of fish flesh, and, pound for pound, there is almost as much protein in fish meat as in beefsteak. Oily fish, such as Shad, Herring, and Eel, are especially nutritious. Fish roe usually contains more protein than beef and some fat in addition.

themselves unbidden guests, which the uneasy host can cast off only when it molts.

Grain-eating birds swallow their food whole and, with the aid of gravel or other hard material, pulverize it in their gizzards. The Lobster handles the situation differently. It chews its food before passing it into its mouth. The cutting teeth of its outer mouth parts chop the material into mincemeat, which is passed into the mouth proper in a slow stream of fine particles. From there the food reaches the stomach, which is divided into two parts—the forward section for storage and the rear compartment for sorting, straining, and digesting the food. Between the two are three teeth, one upper and two lower, which, like upper and nether millstones, grind the food to its appropriate degree of fineness.

WHAT SELF-AMPUTATION MEANS

When one examines a Lobster carefully it is seen that the two great claws do not terminate alike. The one ends with a large crushing type of pincers and the other with a seizing type. One of the strange things in connection with these great claws is that Nature has given the Lobster power not only to amputate them in case of danger, but to grow others in their place after amputation occurs.

Imagine a man with his hand caught in a machine suddenly giving a severe jerk and severing his arm at the elbow! And then imagine him going off to himself and growing another arm to take the place of the lost one! That is comparable to what the Lobster does.

In a census of more than 700 Lobsters, 7 per cent were found to have thrown one or both great claws, and these showed every stage of the regenerative process. Nature has arranged matters so that no tendons or large blood vessels cross the breaking point, hence there is little bleeding at the operation.

That the self-amputation of the claw is a matter of will is shown by the fact that when put under an anæsthetic, the Lobster “forgets” to amputate the captive member.

GLUING HER EGGS FAST TO HER BODY

When the female Lobster lays her eggs she turns over on her back, using her large claws and her tail-fan as a tripod to support herself. She flexes her abdo-

men to make a sort of pocket, to which she glues the eggs fast. An 8-inch female will lay about 5,000 eggs, a 10-inch individual about 10,000, and a 19-inch one some 75,000, there being about 6,000 eggs to the ounce (see page 11).

MANY MYSTERIES OF THE SEA

The eggs are carried about for ten months. After hatching, the larvæ spend from three to five weeks irresponsibly floating around near the surface, somewhat lacking in the powers of coördination and orientation. During this time they undergo four molts. At the third molt after hatching the Lobsters begin to take on the characteristics of the adult. At this stage the instinct to desert the surface and seek the bottom suddenly asserts itself, and the Lobsterling settles down to its new environment to eat and grow, reaching maturity in five or six years.

While the ocean literally teems with life, man has learned to make comparatively small use of it, and the list of fishes fit for food is infinitely longer than the list of food fishes. The things yet to be found out about marine creatures are vastly more numerous than the things already discovered.

Imagine a race living somewhere on table-lands towering above our atmosphere, and possessing craft lighter than swan's-down; and then imagine them launching out on the surface of the oceans of air, with clouds forever shutting out a view of the earth below.

Now and then one of their craft might drop a dredge. The sounding tube might sink into the soil of a cornfield or the mud of a river bank.

LIFE UNDER INCONCEIVABLE PRESSURE

The dredge might capture a bumblebee or a butterfly. It might conceivably get a field mouse or a pine cone. But, whatever it got, how little that would be compared with the vast number of things that would escape!

And so it is with our knowledge of the sea and the vast numbers of creatures that inhabit its depths! Even on the floor of the deepest trench in the abysmal region of the sea's bottom, where no ray of light ever reaches, where Stygian darkness is perpetual, where all but freezing temperatures never cease, and where in-



HOW A CRAB DISCARDS ITS OUTGROWN OVERCOAT

The difference between a hard-shell and soft-shell crab is simply one of time. Every now and then the crab needs to grow a little, so its body gets soft and its hard shell splits open. It is then enabled to pull itself out of that shell and to grow while a new one is in the process of forming. When this process of growing and hardening is completed, it ceases to be a soft-shell crab and once more joins the ranks of the hard-shells. This change takes place several times a season.

conceivable pressures prevail, the miracle of life still goes on!

In some of the ocean depths the pressure exerted would be equal to that of a block of limestone three feet square and six feet high resting on a square inch of surface. A creature five feet long with an average girth of four feet would have to sustain a pressure of some 20,000 tons.

In size the denizens of the deep seas range from microscopic to mammoth creatures. Occasionally huge hulks of

flesh of a tough, fibrous nature, unlike that of any known creatures, are washed ashore. One such hulk was 20 feet long, 40 feet around, and weighed many tons. It was believed to be a fragment of some giant of the sea floor, torn loose by a cataclysm of the deep.

RELATIVE AREA AVAILABLE TO MARINE AND LAND FAUNA

The area of the sea is three times that of the land. Its average depth is more than two miles. The sea has 138 times



Photograph from Canadian Motion Picture Bureau

PACKING SARDINES

Sardine packing had an early origin on the Maine coast as a more lucrative outgrowth of the Herring industry. The quantity of canned fish has increased by leaps and bounds, Salmon ranking first and the Sardine second. The total value of canned fishery products was more than \$46,000,000 in 1921.

as much territory 12,000 feet below sea-level as the land has 12,000 feet above.

While man and the terrestrial fauna are able to command only the surface of 57,000,000 square miles of land, the marine fauna has 140,000,000 square miles of sea, with scores, if not hundreds, of depth zones over most of this area, each with its own characteristic forms of life. The water level of the oceans would have to be lowered 10,000 feet to bring about an even division of the areas available for life of marine and terrestrial faunas.

With the great existing disproportion in area between the land and the sea, it is evident that the human race, with its

seemingly insatiable mass appetite, will have to look more and more to the sea for its food.

THE RESULTS OF OVERFISHING

And yet on every hand one already sees the results of overfishing on many of the species now entering the fish markets.

The anadromous fishes, particularly the Shad and the Salmon, are growing scarcer and higher-priced with each passing year.

Between overfishing and stream pollution, the fresh and brackish coastal waters are seeing their fisheries depleted rapidly toward the vanishing point.



© Ewing Galloway

BUYERS MATCHING FINGERS IN THE DIVISION OF BARRELS OF FISH AMONG THEM

"Mora," or finger matching, is a very old Italian game. It is played either for wagers or for fun and the Italians are very skillful at it. Shore Haddock, landed only a few hours after being caught, enjoy an eager demand at twice the price of offshore Haddock.

The Atlantic Salmon has disappeared from many rivers. Along the Maine coast the catch has dwindled to one-seventh of what it was in 1889. The Housatonic, the Thames, and the Saugatuck are Connecticut rivers that once were nationally famous for their Salmon, but which now yield none.

The Shad is going the way of the Salmon. The supply in the Potomac and the Susquehanna is gradually declining. In the Connecticut River the catch in 1923 was only one-tenth as large as that of 1903. The Hudson and the Merrimac know this fish no more.

Similarly alarming conditions occur among other species. The Smelt has disappeared from the Naugatuck, the Striped Bass from the lower Hudson and the East River. Twenty years ago as many Weakfish were caught off the northern New Jersey shore in a week as now are taken in a season.

The same condition prevails in the shellfish fisheries. Oysters, in spite of Governmental and State watchfulness,

are disappearing from beds where once they were plentiful.

The story of the constant yearly depletion of the Lobster fishery is told in every area where the fishery exists.

THE DECLINE OF THE LOBSTER FISHERY

In colonial times Lobsters were so plentiful that even the poorest of the people might feast to their heart's content on this succulent crustacean.

Even as late as 1889 the catch in the United States reached a total of 30,000,000 pounds, which sold for \$800,000—less than three cents a pound. Ten years later the catch was only half as large, while the price had more than doubled.

In 1880 Maine produced 14,234,000 pounds, which sold for less than two cents a pound, as compared with 5,545,000 pounds in 1922, which sold at 26 cents a pound at the wharf, and heaven only knows at how much to the ultimate consumer. The catch of Maine alone, in 1880, was greater than the total catch from Delaware Bay to the Canadian shore in 1922.

Where stream pollution is the chief cause of the decline of the fisheries, nothing except radical protective legislation to save the streams will avail. The Government has found that a pound of bark to 30 gallons of water will kill Bass in one day, and that even a pound of chips to seven gallons of water is fatal to Salmon fry.

If such simple pollutions as these destroy fish by the wholesale, what destruction is wrought by oil and tar, sludge and bilge!

Overfishing may be combated in two ways—by artificial propagation and by restricting the catch, either as to season or as to size—in short, applying common sense.

Artificial propagation has proved its value in the case of fresh-water and anadromous fishes. The Shad fishery continues only because the U. S. Bureau of Fisheries has preserved it by artificial propagation. The same is true of the Salmon.

THE "DANGEROUS AGE" IN FISHES

But for marine fishes, authorities differ as to the value of methods at present employed. As new knowledge of the sea is gathered, however, there come reasons to believe that conditions may be established under which artificial propagation can be made a success.

It has been found lately that there is a dangerous age for the fry of fish, just as there is for the children of men. We know that more children die between the day of their birth and their second birthday than during the next twenty years, because of the high mortality from diseases of infancy.

Likewise, it has been demonstrated that the first few weeks of a fishling's career constitute a high mortality period, in which thousands die where one survives.

PLANKTON AND ITS RELATION TO FISH LIFE

If safe artificial methods could be devised to bring the fry past the critical period, their chances of survival would be vastly improved. It has been found that usually this period of wholesale decimation is reached about the time of the absorption of the yolk sac.

Apparently at or before this stage minute forms of plankton—the mass of

passively floating or weakly swimming plant and animal life near the surface of the sea—are needed as food by the fry that can no longer draw on the yolk sac for nourishment, and without this plankton they die.

The scarcity or abundance of plankton has been found to depend upon sunlight and temperature, and the examination of the scales of fish reveals that in any school of adults there is a great preponderance of some particular age. Figuring back, this class coincides with the year most favorable to the development of plankton.

This affords a clue to the discovery of a method by which marine hatcheries may bring their salt-water fry past the dangerous age before releasing them—a thing that cannot now be done.

This line of investigation shows how important the study of marine life is, what invaluable revelations it may yield, and the splendid character of the results that may be attained therefrom.

The United States Bureau of Fisheries has recently published a paper on the Lobster which shows how an understanding of marine life leads to a solution of the problem of its conservation.

SAVING THE LOBSTER FISHERY

To meet the alarming decline of the Lobster fishery, the several States interested in its protection have enacted various laws. Some have provisions for a closed season, in which the taking of this crustacean is forbidden. Laws prohibiting the destruction of female Lobsters "in berry"—that is, carrying their eggs after laying them—have also been enacted.

In addition to the protection thus offered, attempts have been made to propagate them artificially, by hatching and liberating the fry.

Existing policies, however, have not checked the decline, and recent studies show that new forms of protection and propagation must be adopted if the fishery is to be saved. Dr. Herrick, America's foremost student of the Lobster problem, proposes the abolition of the closed season, which he considers a futile practice. He would adopt a double gauge, under which traps would be prohibited that did not permit the escape of all Lobsters under 9 inches, and make impossible the entrance



Photograph from U. S. Bureau of Fisheries

SAVING THE NEW ENGLAND LOBSTER FISHERY

These men are bringing egg-bearing lobsters to the hatchery at Boothbay Harbor, Maine. The Bureau of Fisheries, in coöperation with the State authorities, collects egg-bearing lobsters from the fishermen, takes the lobsters to the hatcheries, and saves all the eggs, which would otherwise be lost.

of all over 11 inches. He also would forbid the capture or sale of all below or above that limit; would protect the "berried" Lobster and fix a bounty for each one delivered to the fishery authorities. He would have young Lobsters reared to the bottom-seeking stage in hatcheries, thus liberating them when the perils of infancy are past.

FISHES OF GEOLOGIC HISTORY

Jordan observes that when a fish dies it leaves no friends. Its body is promptly attacked by scores of scavengers, ranging from the one-celled Protozoa and bacteria to members of its own species. The flesh is soon devoured, the gelatinous substance of the bones decays and leaves the phosphate of lime content to be absorbed by the water. Hence the multitudes die without leaving any trace behind. Once in a great while a few teeth, or a fin spine, or a bone buried in clay may endure, but the exceptions are notably rare.

It is because of this condition that few traces of the earliest fishes of the geologic past have been left. An expedition from the Smithsonian Institution, some years ago, unearthed, near Cañon City, Colorado, what are believed to be the oldest fish remains known to science. They come down from the Lower Silurian age, a time when neither man nor mammal, nor reptile, nor any other living land animal with a backbone, had yet appeared—a time, indeed, when some of the deepest sandstones we know were being laid down.

FORCES OF DISTRIBUTION STILL AT WORK

From early geologic times many things have played important rôles in determining the distribution of the various species of fish. We see those same forces at work to-day.

In New England waters only a beggarly 34,000 pounds of Bluefish are taken annually, while from there to Delaware Bay the yearly catch amounts to more than 3,000,000 pounds.

In the case of Cod, the situation is reversed, there being some eighty times as many Cod taken north of Long Island as south of that latitude.

There are practically no Croakers in New England, but a plentiful supply off the New Jersey shore.

There are few Herring in waters between Long Island Sound and Delaware Bay, while the Menhaden are most abundant there. Temperature is regarded as the principal influence in thus separating the fishes in these two parts of our North Atlantic waters. There are some species that seem to be equally at home above or below the latitude of Long Island, such as the Alewife, the Butter-fish, the Summer Flounder, and the Scup.

Boston is easily the fishing capital of the New World, and yields only to Grimsby, England, as the world's leading fishing port (see illustration, page 16).

In the North Atlantic fisheries, Canada has 43,000 men employed, as against 76,000 for New England and the Middle Atlantic States.

In the United States fisheries north of Delaware Bay, the Menhaden takes first rank in the weight of the catch, with 256,000,000 pounds to its credit.

MENHADEN LEAD IN WEIGHT OF CATCH

There is a wide gap between it and the next group, which includes the Herring, Haddock, and Cod, with 98,000,000, 89,000,000, and 86,000,000 pounds, respectively, as the weights of their annual catches.

Then there is another wide gap, followed by another group, which includes the Pollock, with 25,000,000 pounds; the Flounder, with 22,000,000; the Hake, with 21,000,000; and the Whiting, with 20,000,000 pounds.

The Mackerel leads the fourth group with 17,000,000 pounds, the Weakfish and the Scup following second and third.

The Alewives head the group of four next in importance, with 5,000,000 pounds. The Butter-fish, the Croaker, and the Bluefish contribute 4,600,000 pounds, 4,236,000 pounds, and 3,362,000 pounds, respectively, to the total catch.

The Cusk and the Bonito are the other species that show an annual catch of more than 2,000,000 pounds.

The Lobster fishery yields over 12,000,000 pounds, nearly half of the product being taken from the Lobster pots of Maine.

The abounding wealth of the United States and the high per capita income of the people have made them able to indulge their whims rather than their needs



© Ewing Galloway

UNLOADING HALIBUT: BOSTON, MASSACHUSETTS

In the Gulf of Maine the Halibut has been seriously depleted by overfishing, but fortunately it has been discovered in such abundance along the deeper slopes of the Banks that at first it appeared inexhaustible. New England Halibut fishermen have operated for years in the neighborhood of Sable Island.

for food. Therefore the food they select, both from land and sea, has been chosen more from the standpoint of flavor than from that of nourishing qualities. The choice cuts of beef and the choice varieties of fish are taken and the remainder all but discarded.

They have been particularly slow to adopt new salt-water fishes into their diet. What was ignored yesterday comes into the market to-day, and to-morrow it acquires a vogue.

It is not so long ago that the Pollock was in such small demand that it was scarcely worth the taking. So also with the Tuna. But to-day both find ready sale, the latter particularly in cans.

The Flounder, likewise, used to be eaten only by the initiated few; but now it is one of the most ready sellers. So it has been with the Haddock and the minor Salmons.

TRAINING THE NATIONAL TASTE

Sea Mussels and Tilefish (see Color Plate, page 53) show how the public taste can be trained under proper guidance, and as the population of the country grows we shall follow Europe in the utilization of marine resources to supplement our land crops. To-day we eat only about a third as much fish per capita as the people of Europe, and have only scratched the surface in promoting the utilization of our food-fish resources.

We have overfished a few of our species, but the great majority have barely been touched. Even those which constitute our principal fisheries are yielding, with a few exceptions, only a fraction of what they could offer, if marketing facilities were better.

Three basic handicaps—perishability of the product, unevenness or uncertainty of supply, and unsteady consumer demand—have kept the fresh-fish industry from developing as it should.

FRESH FISH TO EVERY MARKET

Other products have one or two of these handicaps: milk is perishable, but considered imperative; canned goods have an uneven demand and supply, but only fish suffer from all three conditions.

But lately ways are being discovered to overcome the perishability of fish. Methods of precooling have been found by which the fish can be frozen as soon as

taken, in low-temperature brine, insuring the thorough cooling of every shred before chemical change sets in.

Then the fish is encased in an individual film of ice and sent to market. The housewife who buys her fish in this ice jacket can then know it is perfectly fresh, having been kept so from the hour it was caught.

A fresh fish bought in a market stall is seldom as fresh as a frozen fish pre-cooled when caught, and once this type of frozen fish becomes widely available, it is safe to predict that the zone in which marine fishes are eaten fresh will reach much farther back from the coast than it now does.

Other methods of securing new patrons of the marine fisheries have been tried with success. Last winter two Boston wholesale fish dealers tried putting up choice cuts of Haddock in consumer packages wrapped in parchment paper. The experiment was so successful that these packages have found favor as far away as Denver.

A Boston forwarder took a step in another direction in the extension of the fresh-fish market. He undertook to gather the less-than-carload lots of fish consigned to Philadelphia or other cities and to ship them through in carload lots with a large saving of transportation costs and increased expedition in handling.

SHIPPING LIVE FISH TO MARKET

A Canadian fisherman has tried shipping live Lake Trout to New York, with striking success. He sent in one shipment 6,000 pounds of Trout. They were put in four wooden tanks seven feet square and five feet deep, which were placed in an ordinary box car. By means of a kerosene-driven engine the water was kept constantly in circulation. Casualties in transportation were only about 15 per cent, and it is possible that in the future the fastidious can enter their favorite restaurants, peer into a pool, and select the fishes they want to eat—that is, if the demand is great enough to warrant the regular deliveries.

That fish from the sea will help solve the food problem of America whenever it becomes acute is shown by the fact that analyses reveal how readily fish can be used as a substitute for meat.

Fresh Salmon has more nutrients in it,



HOW THE SPORTY SALMON COMES FRESH TO AMERICAN DINNER TABLES

Each of the beautiful specimens from the fishing communities of our northern coasts and Canada rides into American markets in a special berth padded in "frazil-ice" and snow, and thereby is unharmed and delicious when it arrives. Fish packed by this method have been shipped 800 miles inland without showing signs of deterioration.

for instance, than round steak; Shad, more than chicken.

There are some six million farms in the United States, and as the demand for food grows more pressing, each will probably have its own fish pond. Assuming that each farm will utilize only three pounds of fish a week, a total of more than a billion pounds would be available, releasing a nearly equivalent amount of other meat for urban consumption.

PUTTING SHAD IN THE PACIFIC

The United States Bureau of Fisheries has foreseen the day when exact knowledge of the marine and fresh-water conditions that make for an abundant fish supply will be one of our major concerns.

It recognizes that without exact and definite knowledge of all phases of marine biology that affect the lives of the fishes suitable for human consumption, efforts to utilize the food resources of the sea to the fullest advantage must be handicapped so sorely that species which might render rich returns will be neglected, while others that have met with

great favor may be all but exterminated.

The Bureau's work in introducing the Shad into Pacific waters and making it abundant through 2,000 miles of coastline has been a service of the first order. Its success in saving the Atlantic Salmon and the Shad from extermination in such eastern rivers as have not reached the critical stage of pollution is another instance of its unusual value to the nation. Its rescue of the Seal fishery from destruction and its protection of the Alaskan Salmon fishery from inordinate depletion have earned for it a universal appreciation.

Yet these activities are but a prelude to the things that remain to be done.

Thanks to the splendid achievements of the past, in which such men as Goode, Jordan, Evermann, Nichols, Gudger, Bigelow, Barbour, Parker, Eigermann, Townsend, and numerous others have rendered an inestimable service to humanity by their gradual pushing back of the horizon of marine life, ichthyology to-day stands at a point where a correct



LANDING TUNA AT HUBBARDS COVE, NOVA SCOTIA

The Tuna is an inhabitant of many seas. In North Atlantic waters it is known as the Horse Mackerel, in the North Sea as the Tunny, in the Mediterranean sometimes as the Great Albacore, and in California and southern Florida as the Tuna.

appraisal has been made possible of the problems remaining to be solved in order to develop for an ever-expanding race all the potential treasures of the sea.

It is an interesting coincidence that most of the game fishes of salt-water habitat belong to those species that are favorites as food fishes. The lure of the Trout stream and Bass-abounding waters, and the fascination of pursuing the Pickerel and the Muskellunge, the Pike and the Grayling, have brought thrills to millions who have cast a line in fresh water.

SALT WATER GAME FISHES

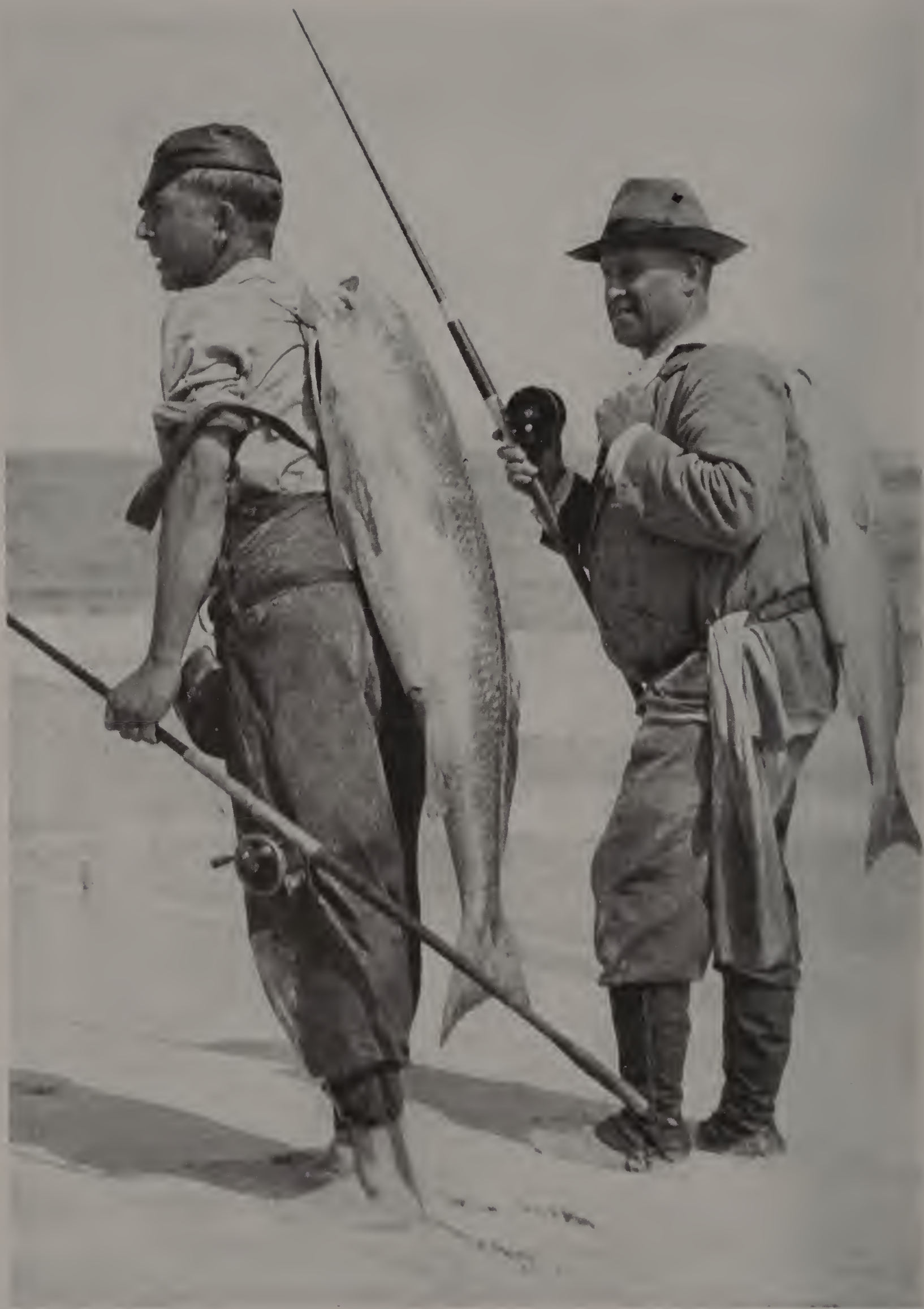
But the man who originated salt-water fishing with rod and reel, where the sport really begins when the game is hooked, where hours of battle are often required to bring the valiant fighter to gaff—hours in which the crown of victory trembles in the balance between fish and fisherman—that man created a sport which is the last word as a contest of human skill and piscatorial gameness.

Angling with rod and reel for salt-water fishes is of comparatively recent origin, but when done “according to Hoyle” it makes the battle between fish and man a fight that gives the fish an even chance, and can be won by the fisherman only through the exercise of his last reserve of skill.

The Tuna, the Black Sea Bass, the Weakfish, the Striped Bass, the Bluefish, the Tautog, and the Sheepshead all offer sport with as many thrills as Tarpon fishing affords, when each is caught with the tackle prescribed by sportsmen’s associations for battle with the respective species.

“THE LION, TIGER, AND ELEPHANT TRINITY”

One authority has called the Tarpon, Tuna, and Black Sea Bass the lion, tiger, and elephant trinity of the angling world. Yet the game is bringing them to gaff with seven-foot rods, weighing not more than 25 ounces, although there may be from 100 to even 400 pounds of game and fighting fish at the other end of the line!



Photograph by H. Armstrong Roberts

TWO SALT-WATER GAME FISHERMEN WITH THEIR PRIZES OF A DAY

These two Channel Bass, one weighing 47 pounds and the other 23, show the possibilities of sport with rod and reel in sea fishing. He who gets a game fish weighing from 40 to 200 pounds on a hook becomes a party to a battle royal in which man and fish may struggle for hours, with victory trembling in the balance all the while and the issue undecided until the very last moment.

It is a battle royal when one of these resourceful and unrelenting denizens of the deep is well hooked by a successful strike, and reel wars against fin—a battle that the novice is almost certain to lose, and that even the veteran of many victories cannot count as won until the gaff has done its work.

The Tuna is an inhabitant of many seas. In North Atlantic waters it is known as the Horse Mackerel, in the North Sea as the Tunny, in the Mediterranean sometimes as the Great Albacore, and in California and southern Florida waters as the Tuna.

In the vicinity of Santa Catalina, California, Tuna angling has reached its high-water mark as a sport. The angling ground is a narrow, four-mile stretch of coast in the lee of the island mountains, where there are several small open bays, generally smooth, with wind blowing only a part of the day. The vicinity of Miami Beach, Florida, is also a favorite hunting ground.

Such a fine fighter needs special tackle, if it is to be taken in true sportsman's style, and if that tackle isn't the best that ingenuity can devise and money can buy, it is safe to wager long odds that the prize will not be landed.

SPECIAL BOATS FOR TUNA

Special boats are required for Tuna fishing as a sport. They are broad-beamed launches, built for two fishermen and the boatman, who serves as engineer, helmsman, and gaffer. Usually each boat



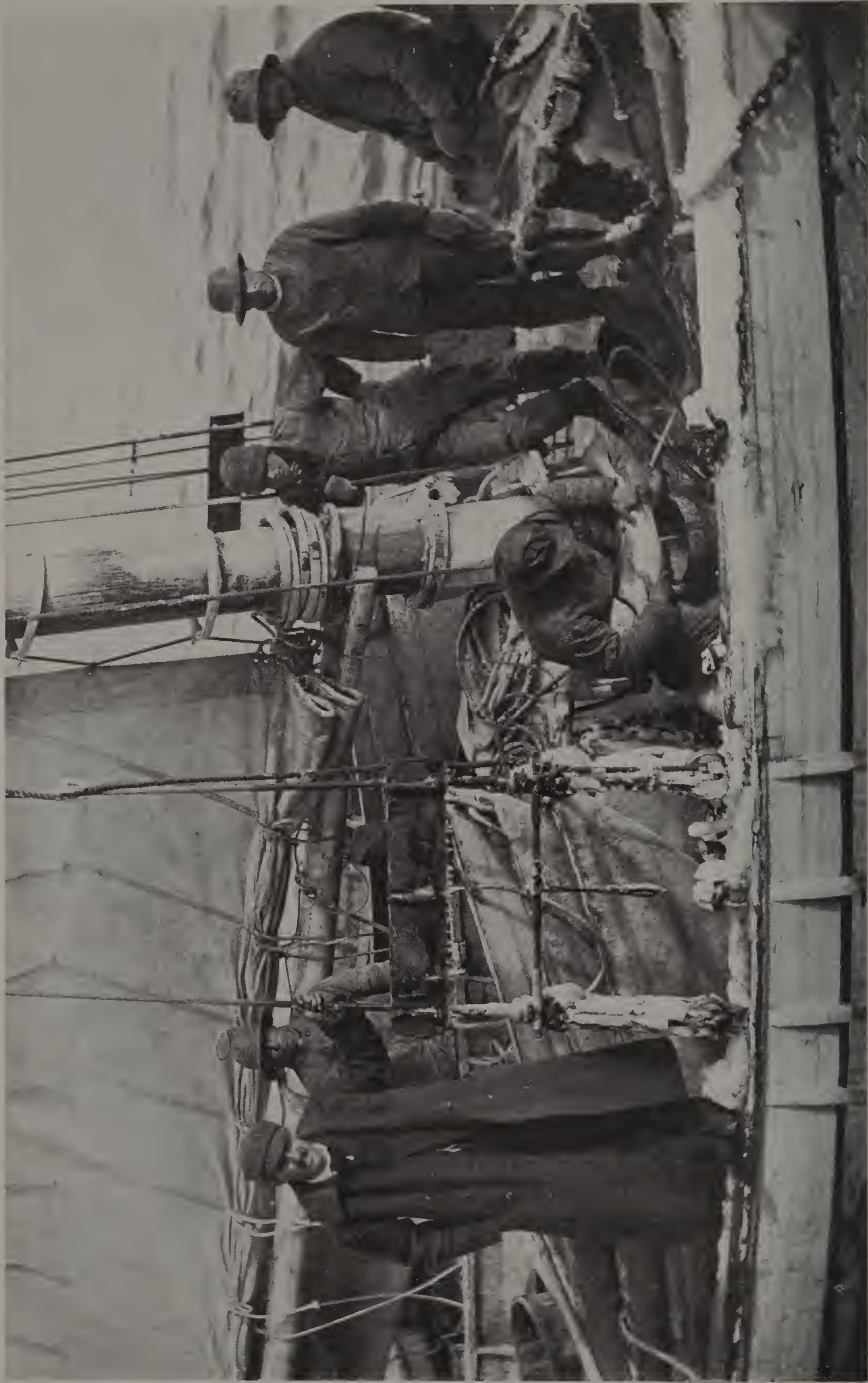
Photograph by Gilbert Grosvenor

LANDING GIANT TUNA FISH, CAPE BRETON ISLAND

The North Atlantic Tuna is the giant of his tribe, specimens weighing as much as 1,500 pounds having been captured. European varieties do not attain more than 500 pounds, and on the California coast they are still smaller. In the Old World the Tuna has been prized as food since the time of the ancient Romans, but it was long in gaining popularity in this country.

is equipped with a three- or five-horse-power gasoline engine.

Once a successful strike has been made, the game is to bring the quarry to the boatside with rod and reel. A little too rigid holding of the rod, a momentary failure to keep the line taut, a little lapse of skill in the manipulation of the reel—in short, any one of a dozen kinds of mishaps and the battle is lost or begun again. Leaping into the air, running hither and yon, diving, darting, and fighting every inch of the way, the great fish gives battle. Often it lasts for hours;



Photograph from U. S. Bureau of Fisheries

FISH HATCHERY EXPERTS REMOVING EGGS AND MILT FROM FISHES FOR ARTIFICIAL PROPAGATION PURPOSES

sometimes the fight ranges over a ten-mile sector.

There are 300 feet of No. 24 Cuttyhunk line to be fought over by man and fish. Now reeling it in to bring the fighting quarry toward the gaff, now playing it out to prevent a jerk that might part it, the battle rages until triumph comes to the sportsman or victory to the fish.

In California Flying Fish is the bait on which the Tuna strikes best. The latter come in large schools between the middle of May and the last of June, and at once divide into companies of from fifty to a hundred.

For awhile they play around on the surface; then suddenly there is a great splash and the fretted waters turn into a boiling spray; the Tunas have sighted a school of Flying Fish, which skim along in frenzy and wild confusion from their natural enemies. That is the signal for which the fishermen have been waiting, and the sport is on.

The Tarpon is not classed as a food fish, but it is to Atlantic waters all that the Tuna is to Pacific, the acme in sea sport fishing.

The credit for originating the sport of Tarpon fishing belongs to William S. Jones, of Philadelphia. Back in the late eighties he was fishing in the Indian River Inlet, in Florida, and chanced to hook a 130-pound Tarpon which was six feet long. For two hours he battled with his quarry and finally brought it to gaff.

Wherever fishermen forgathered in that day, the story of Jones' triumph was told, and soon Indian River Inlet became the mecca of the Nation's rod and reel champions. To-day Tarpon fishing is an established sport at many resorts in southern Florida, both on the Gulf side and in the Atlantic, and clubs strictly regulate the character of tackle to be used to a point where only skill can win.

The vast schools of Mullet upon which the Tarpon preys form the magnet that draws him to the various feeding grounds in Gulf and Florida waters.

Ordinarily one does not think of the Weakfish, or Squeteague, as offering much in the way of sport, but when angled for with appropriate tackle, it can give the fisherman thrills that leave nothing to be desired.

Its abundance and willingness to bite make it popular with anglers who want action. It is a handsome member of the finny tribe. The Cape Cod fishermen call it the "drummer" because of the peculiar noise it makes when traveling in schools. It gets its name "Weakfish" not because

of its lack either of gameness or stamina, but because the bony processes of its mouth are soft and tender.

There is never a doubt when a Weakfish bites. It simply swoops down on the bait and is off with it like a flash. Its soft mouth-parts call for skill in bringing it in. A sudden jerk will tear out the hook, hence the line must always be taut, and the fish must be led in rather than dragged. Rods weighing from ten to fifteen ounces, made of greenheart or bamboo, are prescribed for Weakfish angling, and a fine linen line 300 feet long, with a multiplying reel, is employed.

THE STRIPED BASS AS A FIGHTER

All anglers agree that the fisherman who hooks a Striped Bass with proper tackle has a run for his money. Once hooked, this flashing fighter does not spend its time leaping out of the water, trying to shake the line loose, as does the Salmon.

Rather it makes a first fierce plunge and brings every ounce of its muscular fiber to bear against the line. If this is strong enough to hold it in leash, it seeks to free itself by finesse and strategy. Now it tries to chafe the line over the sharp edge of the rocks to which it runs; failing in that, the fighter will attempt to foul the line in seaweed and kelp.

But if it be of good size and the rod of about 18-ounce weight, with a 12- or 18-thread Cuttyhunk line and a quadruple multiplier reel, it will give the disciple of the Izaak Walton League who hooks it a lively and artistic tussle before throwing up the sponge.

Loving brackish water, the Striped Bass brings the sport of philosophers a considerable distance inland. Roanoke and Potomac rivers, the Raritan and the Passaic, and numerous others afford excellent fishing grounds for Striped Bass.

It is a temperamental fish, shy to a degree at times, now taking one bait and now responding to another. Small Eels, Shrimps, Crabs, and blood worms are to its particular liking.

THE GAME AND GAUDY BLUEFISH

Usually we think of the Bluefish as one of the dependables of the bill of fare; but it has some exciting moments to offer the angler who prefers the rod and reel of the sportsman to the hand line of the pot fisherman.

With a spanking breeze and a moderate sea, the man who hooks a Bluefish



Photograph by Edith S. Watson

FISHWIVES BEHEADING CAPELIN: ISLAND OF ST. PIERRE

The Islands of St. Pierre and Miquelon, ceded by Great Britain to France as shelters for her fishermen by the Treaty of Paris, 1763, are now only relics of the once great French empire in America. Both were formerly very valuable as stations from which France carried on her fisheries on the Banks of Newfoundland. St. Pierre is the smaller, but the more important of the two, and the little town of the same name presents a busy aspect during the fishing season. The American Capelin was so called because early French fishermen saw a resemblance to the European *Capelan*, a small Cod, but the American fish is classed as a Smelt.

earns his dinner. It makes a smashing fight, and the fisherman who lacks the skill of giving proper tautness to his line is likely to find it broken by a sudden rush or shaken loose if allowed to slack.

Though the leader may be of wire, the fish will attempt to swim ahead and bite the line in two with its sharp teeth.

One angler has also described the hooked Bluefish as a wild tiger, with all its strength and courage and deviltry—now running deep, now rushing from side to side, but always pulling and jerking with its entire strength in its mad battle for freedom—a foeman worthy of anyone's steel.

Lobster tail, shedder Crabs, live Killies or small Herrings are tempting tidbits to the voracious Bluefish, which has been called the glutton of the deep.

It is related that Bluefishes are utterly wanton in their gluttony and will prey on a school of lesser fish until their stomachs are so full that they disgorge the harvest and begin all over again.

The Bluefish, like the Striped Bass, brings the joy of salt-water game fishing into many of the Atlantic coast rivers, notably the Hudson, the lower Potomac, and Hampton Roads.



Wide World Photograph

LARGEST STURGEON CAUGHT IN NORTH SEA

A giant Royal Sturgeon which when landed in the North Sea tipped the scale a little short of 1000 pounds, nearly a half ton. A portion of the huge fish was sent to King George for his Christmas dinner.

SEA BASS SLUGGISH ON LINE

Some of the deep-water food fishes offer good sport for the fishermen who go down to the sea in boats to cast their lines. One of these is the Sea Bass, a rather sluggish citizen of the sea, but withal a ready biter and interesting game for those people who like to go out on an excursion steamer that drops anchor on the banks off Sandy Hook, for instance.

Sometimes the Sea Bass breaks water like its river cousin, and makes vicious leaps and contortions in its efforts to free itself; but its jaws are leathery and once well hooked it seldom gets away. An eight-ounce rod is the rule for sportsmen angling for the Sea Bass.

All hands pay tribute to the Kingfish as perhaps the gamest for its size of all the bottom-feeding denizens of salt water. Famous alike for its qualities, its splendid color, its graceful form, and its fine flavor, it was christened the Kingfish by the *bons vivants* of Colonial days, when New York was yet New Amsterdam. It takes bait readily, Clams, bits of fish, shedder Crabs, sandworms, and Shrimps being to its liking. Its tactics when hooked are largely those of the Small-mouthed Bass.

In surf fishing the best time to catch the Kingfish is the first of the flood tide.

The treasures of the sea are many, but none is more certain to yield delight to the true sportsman than the game fishes that disport in its waters. The commercial fisherman, with his seines and hand lines, is perennially harvesting boatloads of sea fish for a large consuming public; but the real joy of the ocean is reserved for those with rods and lines properly designed to put the fisherman and his prize on even terms, where human skill and piscatorial generalship can each have its innings and the issue remains in doubt to the climax.

POLLOCK (*Pollachius virens*)

(For illustration see Color Plate, page 39)

The Pollock, also known as the Green Cod, or Coalfish, has a range that reaches across the Atlantic and as far south as Cape Henry, although it is not taken in commercial quantities south of New Jersey. In size it attains a weight of 35 pounds and a length of 4 feet. It is a voracious eater and very destructive of young Cod. A ready biter, many sportsmen regard it as a fine game fish for rod and reel.

Though a bottom-feeder, the Pollock frequents the surface and intermediate depths. It congregates in large schools, roams from place to place, and preys on all kinds of young fish. Professor Sars tells of witnessing an attack by a Pollock school on a school of small Cod. The latter were completely surrounded and driven into a compact

mass. On the edge of the mass the Pollocks bored in, eating their voracious way, while from above the screeching sea gulls plunged down to share the feast. In dire panic the young Cods darted this way and that and broke through the line as best they could.

The Pollock appear about Cape Cod early in May, passing Race Point so close inshore that they are often caught with seines on the "tide rips." A favorite spawning ground is off Cape Ann, where they stay from early May to late January, and by October get so numerous at times that they annoy the Cod fishermen by taking the bait before it has time to sink to Cod depth.

The liver of the Pollock is particularly rich in oil, the medicinal quality of which is not inferior to cod-liver oil. The Pollock, like the Haddock, is rarely salted.

CODFISH (*Gadus callarias*)

(For illustration see Color Plate, page 39)

The Codfish belongs to a family which comprises many species, including some of our most valuable marine fishes. The principal species are the Cod, Haddock, Pollock, Hake, and Cusk.

Until recent years the annual value of the Cod has exceeded that of its close relatives, but during the past decade the Haddock fisheries have on several occasions assumed the first rank. The Cod owes its value as a food fish to its flavor, size, comparatively few bones, year-round abundance, and adaptability to dry-salting. Fishes rich in oil cannot be successfully dry-salted, and for this reason such species as the Salmon, Bluefish, and Mackerel, if salted at all, must be put into brine.

The Cod is a cold-water fish and its movements are largely governed by changes in the water temperature. However, the temperature in many parts of the North Atlantic is so low throughout the year that the Codfish may be caught in equal abundance the year round. It is generally taken at depths of from 8 to 40 fathoms, but is known to inhabit much deeper water. It is found on our Atlantic coast from Cape Hatteras northward and is also an important species on the European coast. It is taken in commercial quantities in all our Atlantic States from New Jersey northward. Along the New Jersey coast it is found from late November until early May, but off the New England coast and the offshore "banks" it is caught throughout the year.

The Cod is taken with otter trawls, trawl lines, hand lines, and gill nets. The larger vessels employ the otter trawls and are known as "trawlers." Hand lines and trawl lines are the most popular methods of fishing, as their use requires only a small boat and crew. The boats range in size from the small motor and sail type to the large steam trawlers. Nearly all boats now carry engines, and thus are better equipped to encounter the frequent fogs and the violent storms which appear almost without warning, and which were the bane of fishermen of former days.

The Cod is an omnivorous feeder, eating almost anything it happens upon. Its chief food appears to be Mollusks, crustaceans, worms, and fish, but articles such as jewelry, glass, stones, leather, etc., have been found in its stomach. Its omnivorous habit is responsible for the finding in its stomach of rare fishes and shells that otherwise might not have been known to exist.

Spawning takes place along the New England coast from October to June. The eggs are about

one-nineteenth of an inch in diameter and since they float at the surface, many are cast ashore, eaten by birds, or otherwise destroyed. To offset this great destruction, Nature has rendered the Cod very prolific and a good-sized fish may contain several million eggs.

The largest Cod recorded was more than 6 feet long and weighed 211½ pounds, but fish weighing more than 75 pounds are comparatively rare. The usual size of those taken on the banks ranges between 10 and 35 pounds. The Cod is not a game fish, but when hooked by an angler is a welcome addition to his catch.

It is said that the Cod fisheries constituted one of the inducements that led England to establish colonies in America. Their early importance was so great that the Cod won a place on the seal of the Colony of Massachusetts, and in the Massachusetts State House it is honored with an image. The Cod has been portrayed on Nova Scotian bank notes with the legend "Success to the Fisheries," and on the early postage stamps of Newfoundland, where the courts have held that whenever the word "fish" is unqualified it must be taken to mean Codfish.

HADDOCK (*Melanogrammus æglifinus*)

(For illustration see Color Plate, page 39)

The Haddock is close to the Cod both in appearance and in its quality as food. It may be known at sight by the characteristic black lateral line that reaches from gill to tail. The "Finnan Haddie" of commerce, which is said to take its name from Findon or Findhorn, both towns in Scotland, is smoked Haddock. Unlike the Cod, the Haddock is seldom salted.

On the American coast the Haddock rarely is encountered north of the Straits of Belle Isle or south of Hatteras. On European shores its habitat extends from Icelandic waters to those of France and entirely surrounds the British Isles.

More gregarious than the Cod, the Haddock swims in large, compact schools in its migrations from place to place. It is a bottom-feeder and has marine invertebrates for its principal diet, Mollusks seeming to be favored above everything else. The spawning season of the Haddock is from April to June. The average size of those caught is from 2 to 4 pounds, with 17 pounds as about the maximum.

In recent years the catch of Haddock has been so large as to make it a rival of the Cod, which it has occasionally outranked in the annual value of the catch.

WINTER FLOUNDER (*Pseudopleuronectes americanus*), and SUMMER FLOUNDER (*Paralichthys dentatus*)

(For illustrations see Color Plate, page 40)

The Flounder family includes the Halibuts, the Flounders, and the Turbots. The Winter Flounder (*Pseudopleuronectes americanus*) belongs to the Flounder tribe and is an important food fish on the New England coast. Next to the Halibut, it is the most widely caught Flatfish in Atlantic waters, and ranges from Labrador to Hatteras, being especially abundant on the Massachusetts and Connecticut shores. It is not a large species, seldom attaining to more than 20 inches in length and 5 pounds in weight. A large female produces as many as a million eggs, the spawning season being from February to April. This species feeds on shellfish, young Crabs, and similar foods. It is

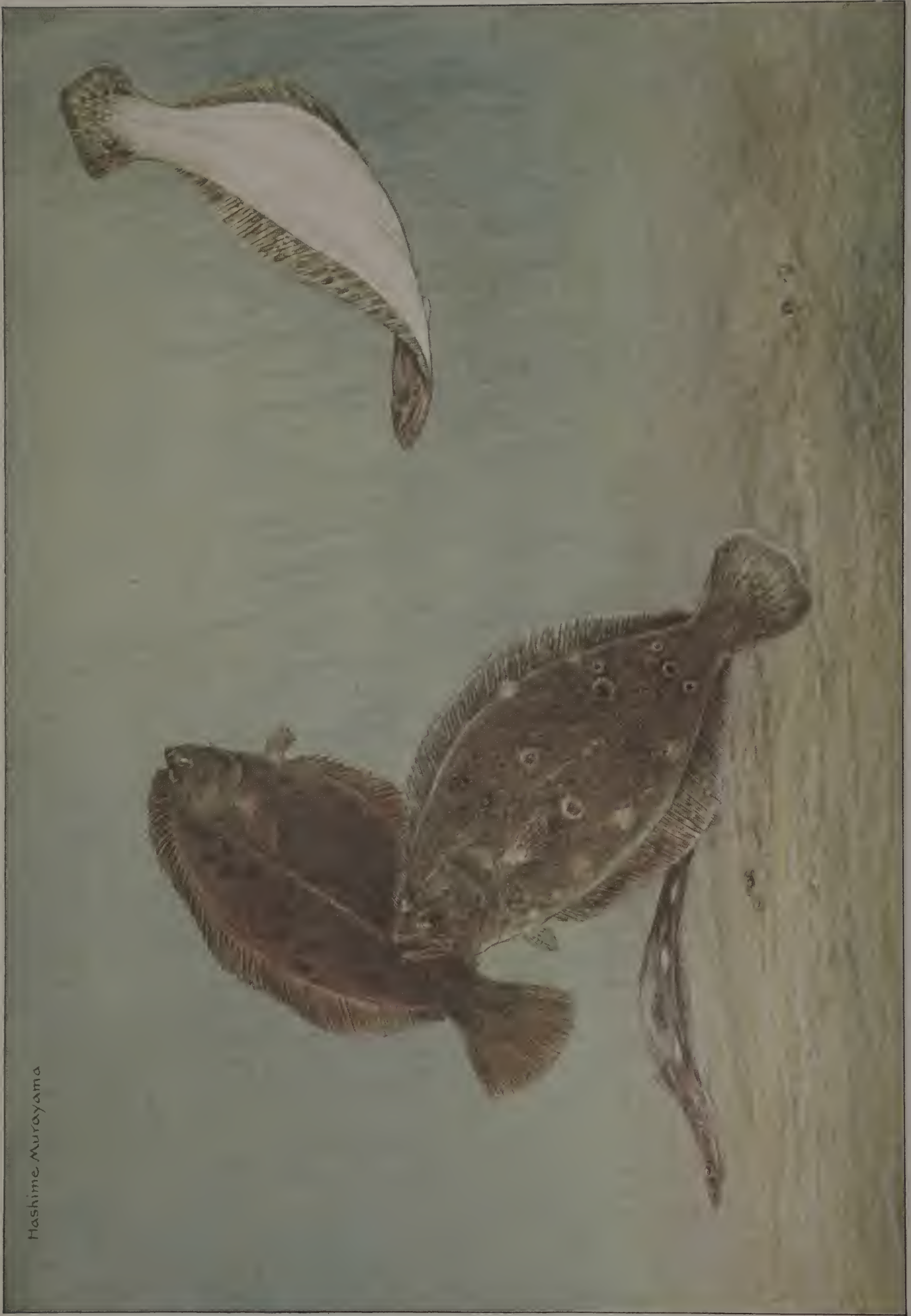


Hashime Murayama

Painted by Hashime Murayama

POLLOCK (*Pollachius virens*) [at top]; CODFISH (*Gadus callarias*) [center]; HADDOCK (*Melanogrammus aeglefinus*)

Ranging across the Atlantic and as far south as Cape Henry, the Pollock, also known as Green Cod, or Coalfish, attains a weight of 35 pounds and a length of four feet. The liver yields an oil not inferior medicinally to that of the Cod. The temperature of many parts of the North Atlantic is so low that Codfish may be caught the year round. The catch of Haddock in recent years has made it a rival of the Cod, which it now occasionally outranks.



Painted by Hashime Murayama

WINTER FLOUNDER (*Pseudopleuronectes americanus*) [upper left]; SUMMER FLOUNDER (*Paralichthys dentatus*) [center]

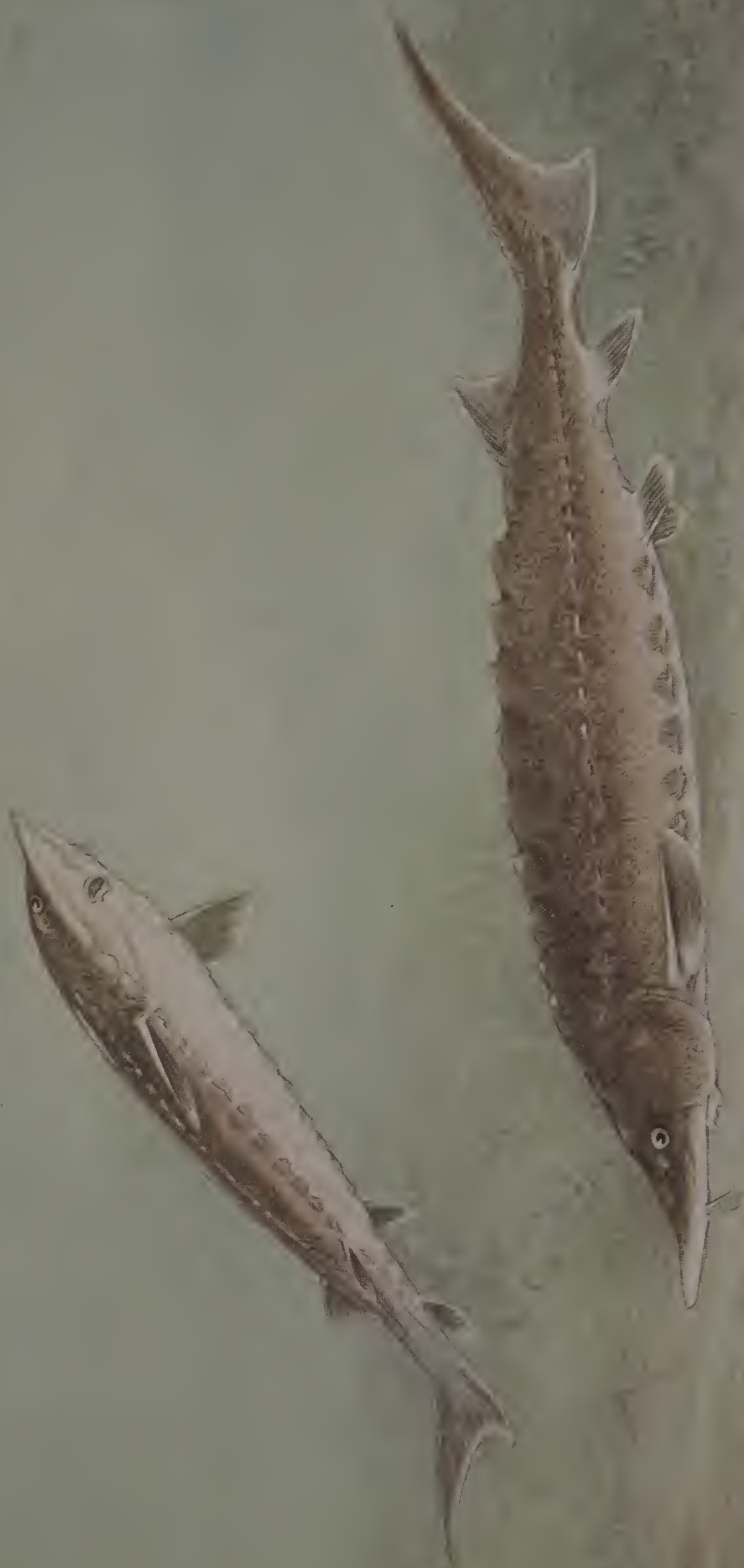
The Winter Flounder belongs to the Plaice tribe and, next to the Halibut, is the most widely caught Flatfish in Atlantic waters. It ranges from Labrador to Hatteras, being especially abundant on the shores of Massachusetts and Connecticut. The Summer Flounder, like the Winter species, habitually lives at the bottom, where its shape, color, and sand-burrowing habits effectively camouflage it. Note the one nearly buried in the sand. The migration of the Flounder's eyes is a strange phenomenon of fish life (described in text).



Painted by Hashime Murayama

HALIBUT (*Hippoglossus hippoglossus*)

The Halibut is the largest fish of the Flounder family, claiming all seas in regions north of 41 degrees for its habitat. Species inhabiting cold water have eyes and color on the right side. The Halibut is found mostly in deep gullies between offshore banks and on the outer edges of those banks in water 100 to 350 fathoms deep. Like the Flounder, the Halibut buries itself in the sand to hide from its enemies and to catch its prey.

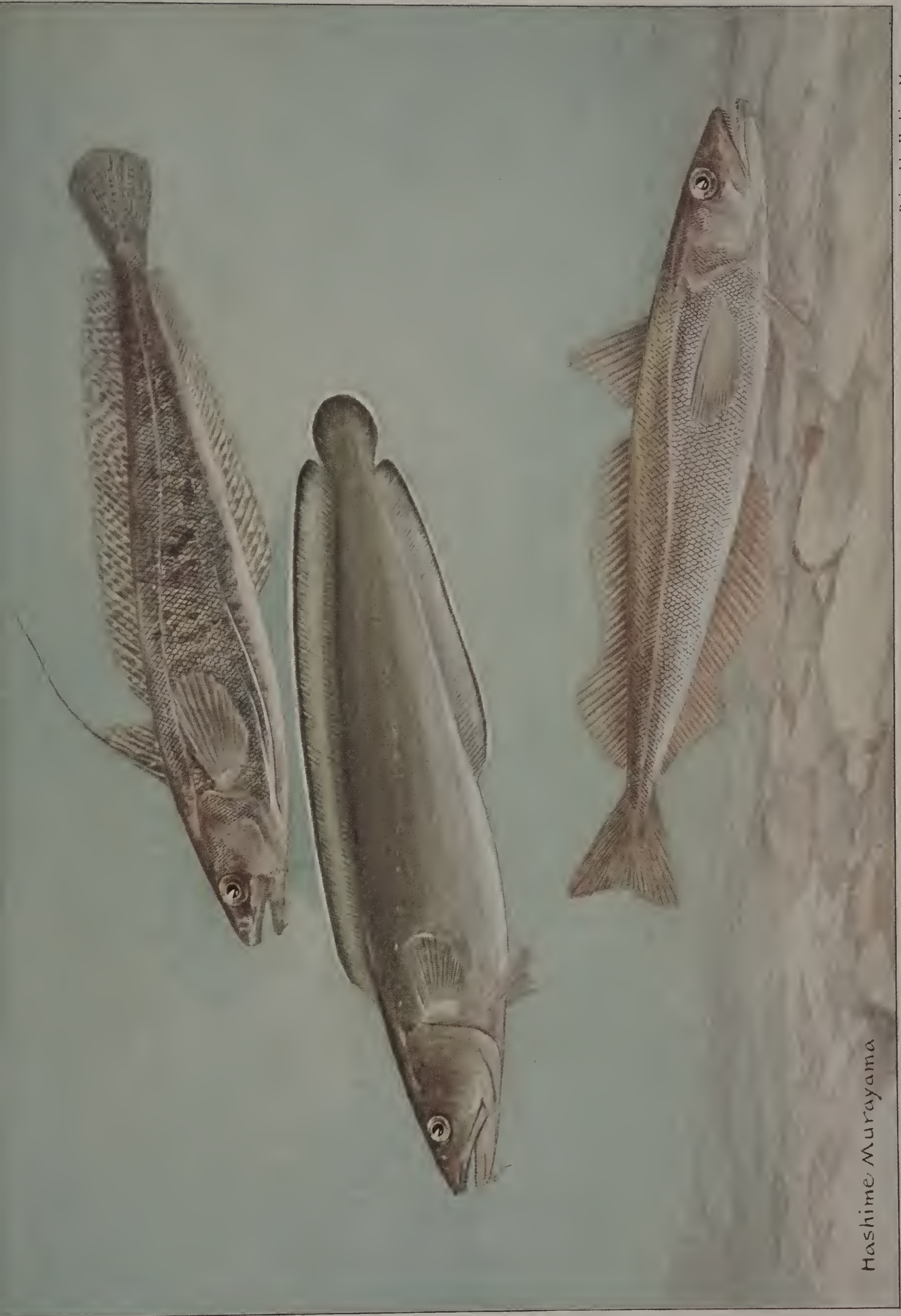


Hashime Murayama

Painted by Hashime Murayama

COMMON STURGEON (*Acipenser sturio*)

Common Sturgeons are found from the Carolina coast to the Maine Gulf, with the Delaware River the region of their greatest abundance. Once they were plentiful, but over-fishing has so reduced the supply that the taking of one is decidedly rare, and when taken living it sells for several hundred dollars. The spawning season is regulated somewhat by the temperature of the water, May being the usual month in the Delaware River. The eggs are used in making caviar.



Hashime Murayama

Painted by Hashime Murayama

SQUIRREL HAKE (*Urophycis chuss*) [at top]; CUSK (*Brosmus brosme*) [center]; WHITING (*Merluccius bilinearis*)

The Squirrel Hake, belonging to the Codfish family, ranges from Labrador to Hatteras on the Atlantic coast. It is used in making boneless Cod, and its air bladder is used in the manufacture of isinglass and glue. The Cusk, also a member of the Codfish family, is widely caught in the present New England fisheries. The Whiting, sometimes known as the Silver Hake, commonly inhabits the middle depths of the continental slope.



Hashime Murayama

Painted by Hashime Murayama

MACKEREL (*Scomber scombrus*)

The Mackerel is a member of the family which includes the Bonito, Tuna, Kingfish, and the Wahoo or Peto. It ranges between Hatteras and the Straits of Belle Isle, appearing on the Hatteras coast in early spring, and gradually migrating north. The spawning season extends from May to July, the grounds being in rather deep water off the coast between Long Island Sound and the Gulf of St. Lawrence. The Mackerel has many enemies, among which are the Gannets, Porpoises, Whales, Sharks, Squids, and Dogfish.



Hashime Murayama

Painted by Hashime Murayama

TUNA (*Thunnus thynnus*)

The Tuna belongs to the Mackerel family, of which it is the largest representative, and has a wider distribution than most fishes. It is found in all warm seas, and occurs as far north as Newfoundland. On the North Atlantic coast it is caught from early summer to October. During one season a single fisherman harpooned thirty Tuna of an average weight of 1,000 pounds, although some weighing up to 1,500 pounds have been taken.



Hashime Murayama

Painted by Hashime Murayama

SHAD (*Alosa sapidissima*)

Belonging to the Herring family, the Shad spends its spawning season in the rivers and the rest of its life in deep sea waters. Because it is not within reach of fishermen except at the spawning season it is especially liable to extinction by over-fishing, and were it not artificially propagated it now would rarely appear on the American dinner table. Through the work of the United States Bureau of Fisheries it has been established along some 2,000 miles of Pacific Coast shore line, from the Atlantic seaboard, where it is indigenous.



Hashime Murayama

Painted by Hashime Murayama

ALEWIFE (*Pomolobus pseudoharengus*) [at top]; HERRING (*Clupea harengus*)

The Alewife, variously known as the Branch Herring, the Bleary-eyed Herring, the Wall-eyed Herring, and the Gaspereau, is found on our Atlantic coast from the Carolinas northward. The Herring family includes the Sardines, Alewives, Shad, and Menhaden. *Clupea harengus* is probably the most important food fish in the world, and is distributed throughout the North Atlantic Ocean. Unlike most fishes, the Herring is particularly fine-flavored at spawning time.



Hashime Murayama

Painted by Hashime Murayama

TAUTOG (*Tautoga onitis*)

The Tautog, a stockily built member of the Wrasse family, ranging from New Brunswick to the Carolinas, is variously known as the Tautog or the Blackfish. Its food consists mainly of hard-shelled Mollusks, Squids, Scallops, Crabs, Barnacles, and Sand Darters. It eats shell and all, and regurgitates the indigestible parts. The Tautog's scales and mouth are hard, and it possesses an eel-like slipperiness.

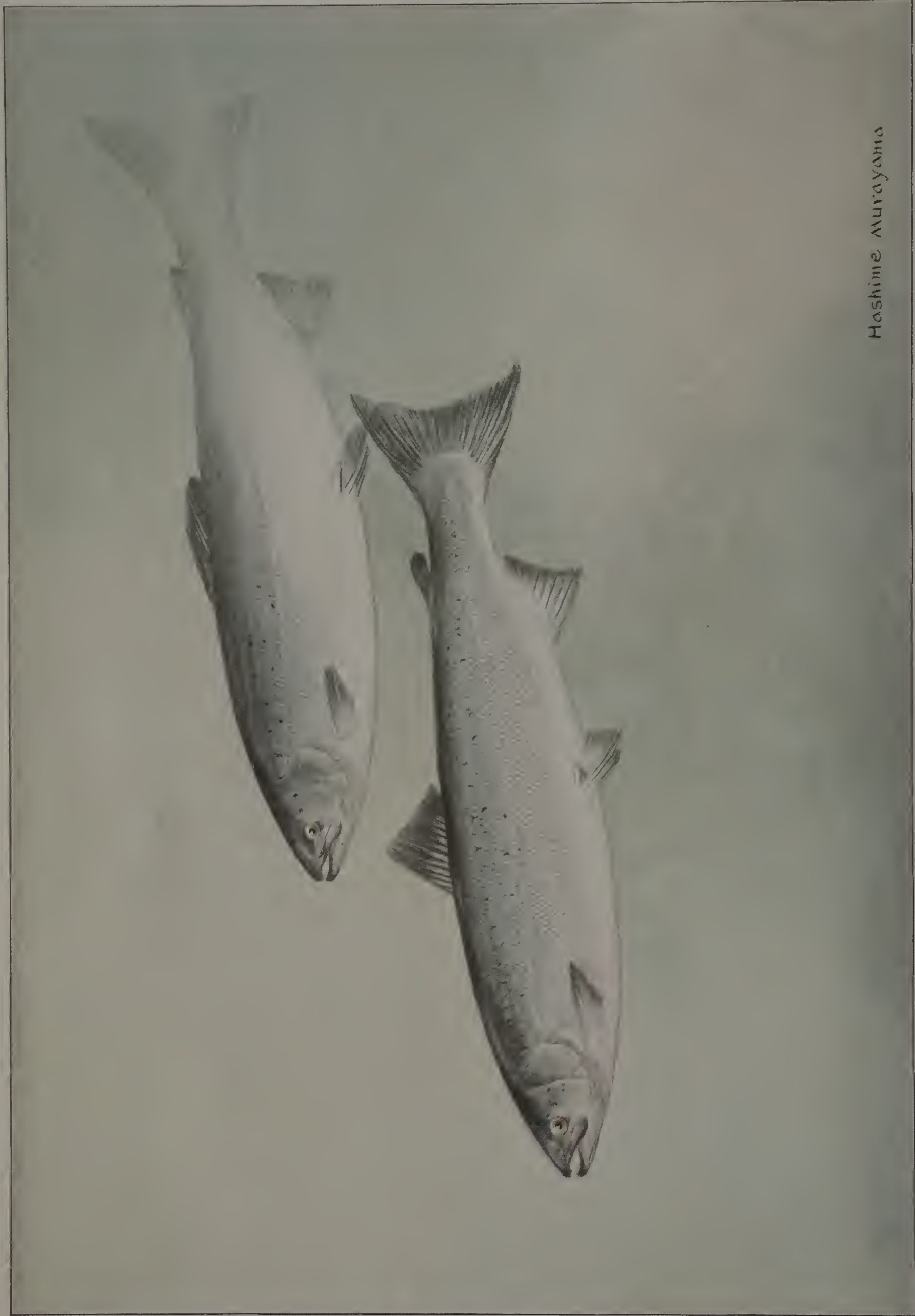


Hashime Murayama

Painted by Hashime Murayama

BUTTER-FISH (*Poronotus triacanthus*) [at top]; SCUP (*Stenotomus chrysops*)

Known as the Dollar-fish in Maine, the Butter-fish in Massachusetts and Norfolk, and the Pumpkin Seed in Connecticut, *Poronotus triacanthus* arrives and departs with the Mackerel. It has the habit of accompanying, in small groups, the Sun-squall Jellyfishes, but whether for the shelter of the Sun-squall's disks, or for the diet of soft-bodied invertebrates entangled in the latter's tentacles, is not known. The Scup of New England is the Porgy of New York, and the Fair Maid farther south.



Hashime Murayama

Painted by Hashime Murayama

ATLANTIC SALMON (*Salmo salar*)

At least half of the Salmon's life is spent in the ocean, the other half in fresh water, where it spawns. Although temperature changes do not influence its movements as much as those of other species, the eggs are not deposited before the water has fallen to 50° F. It seems to enter the rivers on a rising temperature, and may be found in the Connecticut in April and May, in the Merrimac in May and June, and in the Penobscot in June and July.



Hashime Murayama

Painted by Hashime Murayama

SWORDFISH (*Xiphias gladius*)

Sometimes reaching a weight of 800 pounds, the Swordfish rivals the Shark in size and strength. Its distribution is wide; it is the *Zwaard-fis* of the Dutch, the *Sofa* of the Italians, the *Espada* of the Spaniards, and the *Épée de Mer* of the French. The Swordfish is a worthy antagonist, and it is recalled that many a small vessel has limped into port leaking badly as a result of attacks by wounded Swordfish.



Hashime Murayama

Painted by Hashime Murayama

SMELT (*Osmerus mordax*)

With a range from the Virginia Capes to the St. Lawrence Gulf, *Osmerus mordax* is the leading American Smelt. Large quantities of Smelts are taken during the winter, most of which are frozen and shipped to the larger cities. Those shipped in their natural state are termed Green Smelts and are rated very high for table use. This fish is structurally similar to the Salmon, except in size. The stomach of the former is a blind sac with two openings close together, while that of the Salmon is siphon-shaped.



Painted by Hashime Murayama

TILEFISH (*Lopholatilus chamaeleonticeps*)

In 1879 a New England trawler, fishing for Cod off the Nantucket coast, took five thousand pounds of Tilefish—the first of which there is any record. A few years later literally millions of Tilefish were found dead, floating on the waters of the North Atlantic. The solution of the mystery of their destruction and the prediction of their return constitute a notable chapter in the history of marine biology.



Painted by Hashime Murayama

AMERICAN LOBSTER (*Homarus americanus*)

With the supply constantly growing scarcer, and prices ever rising, the Lobster fisheries of New England appear to be doomed unless new legislation, framed in the light of the results of the biological investigations of the United States Bureau of Fisheries, is enacted promptly. The steps recommended include the licensing of every Lobster fisherman and the adoption of a standard trap or pot which shall permit the escape of all Lobsters under nine inches long and prevent the entrance of all over eleven inches.

a favorite with many anglers, being one of the few shore fish that can be caught during late winter. In the vicinity of New York hundreds of anglers may be seen fishing for Flounders on favorable days during March and April.

The Summer Flounder (*Paralichthys dentatus*) or Plaice, also highly regarded as a food fish, is in some quarters known as the Fluke. It is distinguished from the Winter Flounder by having a large mouth, whereas the other has a very small one. It averages in size from two to eight pounds and compares with the Turbot and the Brill of the English coast. The largest one recorded weighed 19½ pounds.

The Summer Flounders, like the Winter species, habitually live on the bottom, where their shape and color camouflage them and give them opportunity to catch their prey. They are found mostly in bays, on sandy, muddy, or rocky bottoms. Feeding on small fishes, Crabs, Shrimps, and Squids, they frequently come to the surface in pursuit of their prey.

The migration of the eye in Flounders is one of the strange provisions of Nature for the protection of the Flatfish tribe. In early youth the Flounders swim about normally, with their eyes symmetrically placed; but as the fishes develop they lie flat in the sand, some species on one side and some on the other, and the right eye migrates over to the left side, or vice versa, so that they ultimately have both eyes on one side of their heads.

HALIBUT (*Hippoglossus hippoglossus*)

(For illustration see Color Plate, page 41)

The Halibut is the largest fish of the Flounder family and one of the most widespread in its range. It claims all seas for its habitat, in regions north of Havre, New York, and San Francisco.

A strange fact concerning this and other cold-water species is that they have eyes and color on the right side, while species inhabiting warm water have eyes and color on the left side.

The Halibut usually frequents offshore banks and exists in great numbers in many localities, but is sought after with such eagerness that it is gradually decreasing in numbers. It grows to a large size and fish weighing 200 or 300 pounds are often taken. The record weight was established when in June, 1917, the *Eva Avina*, fishing 50 miles off Thatcher Island, Massachusetts, caught a Halibut 9 feet 2 inches long and 4 feet 2 inches broad, weighing 625 pounds dressed.

The seaward movement of the Halibut has been noted by American fishermen. When the taking of Halibut first began, it was most abundant on Georges Banks. Later it gradually disappeared from those banks and went farther out to sea. It is now found mostly in the deep gullies between the offshore banks and on the outer edges of those banks, in water 100 to 350 fathoms deep.

A voracious eater, the Halibut feeds upon the Skate, Cod, Haddock, Menhaden, Mackerel, Herring, Lobster, Cusk, etc. Crabs and Mollusks are also to its liking. Instances are recorded where it has attacked Codfish and stunned them by the flip of its tail. One was so busy putting a big Cod *hors de combat* that it allowed a dory to steal up and capture it before it had become aware of its peril.

The female Halibut becomes heavy with roe in July and August, and instances have occurred where such a large quantity was taken from one of them that a good-sized man could scarcely carry it.

COMMON STURGEON (*Acipenser sturio*)

(For illustration see Color Plate, page 42)

The Common Sturgeon has a maximum length of about 10 feet and sometimes reaches a weight of 500 pounds. Its range is from the Carolinas to Maine, but the region of its greatest abundance is the Delaware River. It is a migratory fish, spends most of its time near the shore, and then runs to brackish or fresh water to spawn.

Considerable change in the Sturgeon's appearance takes place as it grows older. The young have more slender and protuberant snouts than their elders. The sexes also differ, in that the male has an oblong head, with a wide, blunt snout, while the female's head is triangular, rapidly narrowing from the back to the snout.

A bottom-feeder, the presence of Mussel and other shell fragments in its stomach, as well as of mud containing the remains of small crustaceans, tells of its habit of scooping its dinner from the floor of the sea. The barbels and lips are sensitive in the detection of food, but the snout is used to root up the soft bottom of shoal places in search of something to eat.

Goode assures us that this fish is prone to jump out of the water at an angle and may project its body for some distance. It is so active that it sometimes leaps into small boats. One is reported to have leaped high enough above the water to jump through one of the "dead-lights," near the water's edge, of the hull of a passing side-wheel steamer, and thus to have made itself prisoner.

The spawning season is somewhat regulated by the temperature of the water on the spawning grounds. May is the usual month in the Delaware, and the latter half predominantly so. The spawning fishes, known as "runners," are usually most abundant after the middle of the schooling period. They seek a hard bottom in which to deposit their eggs. The spent females are of little value for the time being, but later they become sleek and fat, and as "cowfishes" their flesh is in prime condition.

The eggs of the Sturgeon are used in making caviar. They are not taken when the female is ready to spawn, but at an earlier period, when the roe is still "hard." The quantity taken varies, of course, with the size and quality of the female, ranging from 5 to 15 gallons in bulk and from 800,000 to 2,400,000 in number.

In the making of caviar the eggs are removed from the fish and gently rubbed over a fine screen, by which they are separated from their enveloping membrane. Under the screen the released eggs fall into a trough, through which they pass into tubs. In these tubs salt is carefully stirred with the eggs, and it draws their watery constituents from them and forms a copious brine. Later the eggs are poured into fine-meshed sieves, where they are allowed to drain until dry. They are then put into casks or cans and are ready to go into commerce.

Overfishing has done vast harm to the Sturgeon supply. In the early decades of American history



International Newsreel

"HAM AND EGGS" FROM CHESAPEAKE BAY

For years Chesapeake Bay fishermen have fished the Menhaden commercially for its oil and for the production of fertilizer. The oil is pressed out of the cooked fish and sold for use in making soap, paints and a few other commodities and the remaining solid matter is sold for fertilizing material. In recent years, however, it has been found that the dried fish flakes, which were going into the ground, will make hens lay more eggs and will induce hogs to put on fat in record-breaking time. Specially constructed ships make big hauls of thousands of these Menhaden.

It was not much in favor, though New Yorkers ate some of it as "Albany beef"; but in later decades it became a popular market fish, and along Delaware Bay were hundreds of fishermen who earned their living catching Sturgeon and making caviar. Women and children spent their long winter evenings making Sturgeon nets. In all the bay-side towns there were Sturgeon boats awaiting the coming of the fish.

In those days the Sturgeons were plentiful, and caviar sold for from \$9 to \$12 a cask, which contained 135 pounds, and the output ran up into the thousands of casks. But overfishing and heedlessness of consequences sealed the doom of the fishery. Caviar went up to \$120 a cask, even as far back as 1902, and although hundreds of fishermen fished

every day for eight weeks, the best their combined efforts could produce was 68 casks. To-day Sturgeons are rare prizes, worth several hundred dollars each.

SQUIRREL HAKE

(*Urophycis chuss*)

(For illustration see Color Plate, page 43)

The Squirrel Hake and its close relative, the White Hake, *Urophycis tenuis*, belong to the Codfish family and are found on the Atlantic coast from Labrador to Hatteras. They are both ground fishes, staying close to the bottom. They are said to bite best on moonlight nights. The Hake fisheries rank about sixth in the number of tons taken in New England waters annually. They are used extensively in making boneless Cod and for corning. Their air bladders find wide use in the manufacture of isinglass and glue.

The Squirrel and White Hakes resemble each other so closely that even to the trained eye of the zoölogist the difference is not marked. The most tangible distinction is in the number and size of the scales. These are smaller, and therefore more numerous, in the White Hake. In the latter there are about 135 or 140 oblique rows of scales from the branchial opening to the caudal fin, as compared with about 100 in the Squirrel Hake.

These Hakes are not to be confused with another group of fishes sometimes called Hakes, but more commonly known as the Whittings. The representative species of the latter group is *Merluccius bilinearis*, sometimes called the Silver Hake.

CUSK (*Brosmus brosme*)

(For illustration see Color Plate, page 43)

The Cusk is a member of the Codfish family, inhabiting rocky ledges in deep water in the North Atlantic above Cape Cod. It reaches the coast of Greenland and swings around the North Atlantic basin to Iceland, Norway, and Denmark.

This fish disappears from a given haunt after prolonged fishing and moves on to some other ledge. After a lapse of years it may return to the deserted ledge again.

The food of the Cusk consists of Mollusks and small crustaceans. It is an excellent food fish and is widely caught in the present New England fisheries.



Photograph from Ewing Galloway

A FOUR-TON STACK OF FISH IN NOVA SCOTIA

In the northern regions of the earth where man must necessarily be frugal, no portion of fishes rich in oil, such, for instance, as the Cod, is ever wasted. Norwegians mix Cod-heads in the food of their cows for the purpose of making them give richer milk. Icelanders give the bones of the Cod to their cattle, and the inhabitants of the Peninsula of Kamchatka give them to their dogs.

WHITING (*Merluccius bilinearis*)

(For illustration see Color Plate, page 43)

Sometimes known as the Silver Hake, this species is now coming to preëempt the common name Whiting—a term which in former days was applied in divers localities to various species of fishes belonging to as many different families.

It commonly inhabits the middle depths of the ocean or the outer edge of the continental slope, but finds its feeding ground at or near the surface, where it preys upon schools of Herring and other small fish. Usually, when attacking its victims, it congregates in schools of considerable numbers. Its teeth are sharp, and it possesses a large and powerful mouth and a form muscular and lithe, which adapts it to rapid locomotion; for it, like the Pollock, is essentially a fish of prey. Its average length is about a foot.

Prior to 1880 the breeding habits of the Whiting were a mystery. An exploration of the sea bottom off Newport, at a depth of from 150 to 300 fathoms, revealed immense numbers of young fish from one-half an inch to three inches long, and with them were many adults from one foot to one and a half feet long, apparently in the midst of the spawning season.

The New England Whiting is closely related to the European Hake, *Merluccius merluccius*, and to the California Hake, *Merluccius productus*. It appears that the spawning time of the European Hake is from January to April. During this period both species seem to lose the great voracity which characterizes them at other times, and are mostly taken at that season in trawls rather than with lines.



FISHERMEN UNLOADING THEIR HERRING AT A LOCKEPORT CANNERY: NOVA SCOTIA

The Herring family is large and prosperous. It includes such diverse members as the Shad; the Pilchard, the Anchovy, the Sprat, and the Whitebait. All branches of the family have small mouths and either have no teeth at all or very small ones. They are therefore, for the most part, obliged to find sustenance in the myriad of minute animals diffused through the waters of the ocean or lurking among the weeds at the bottom.

MACKEREL (*Scomber scombrus*)

(For illustration see Color Plate, page 44)

The Mackerel is a member of the Mackerel family, which includes the Tuna, the Bonito, the Kingfish, and the Wahoo, or Peto. It ranges as far south as Hatteras and as far north as the Straits of Belle Isle, and, being a shore-loving fish, does not wander far to sea. It first appears on the Hatteras coast in the early spring, and gradually migrates north, its migration seeming to be regulated by the fluctuation of water temperature. Schools 20 miles long and half a mile wide have been sighted. In the seventies an international dispute arose regarding the migration of these fishes. Our Government took the position that the Mackerel do not come from deep water offshore to warmer water inshore, but that they are first found in the spring off Cape Henry and can be followed day by day as they move, in countless hordes, northward to Maine and Nova Scotia. Canada held that they came inshore from deep water offshore. The American viewpoint has been proven correct.

The spawning season for the Mackerel extends from May to July. The spawning grounds are in rather deep water off the coast, stretching between Long Island Sound and the Gulf of St. Lawrence. Prior to spawning the fish are lean and their flesh is of poor texture, but after that task is over they get fine and fat, being regarded as among the best fishes in Atlantic waters.

The food of the Mackerel consists of small crustaceans, Lobster spawn, and the "small fry of the seas." One tiny crustacean favorite is the red, spiderlike creature known as "the Boone Island bedbug," and old fishermen declare that wherever it is found they can afford to wait, for it is bound to bring the Mackerel to its feeding ground.

Many enemies prey on the Mackerel. The gannets often eat so many that they are unable to rise from the sea to avoid a passing ship until they have disgorged several good-sized fish. Porpoises, whales, Sharks, and Dogfish also are dangerous enemies. Indeed, the last named are sometimes so hungry that they will bite the twine of the fishermen's nets to get inside and prey upon the catch at will. They have also been known to follow the catch to the very sides of the ships and swim around the scuppers and drink the blood flowing from the dressing operations aboard the boat.

The Squids also are enemies. They suddenly dart back among the Mackerel with arrowlike speed, and, quickly turning to one side, seize a victim, sink their sharp beaks into the nape of the neck, and kill it almost instantly by severing the spinal cord. Sometimes they fail. When they do, they drop to the bottom and change their color from translucent paleness to that of sand, in order to camouflage their presence while waiting for the Mackerel to return. The latter usually stay well inshore, and are warned of the enemy's presence, for as soon as the Squid gets into too shallow water it begins to pump with great energy and to discharge its ink in large quantities. Thousands of them are stranded and perish when their eagerness for a dinner leads them into shallow water.

TUNA (*Thunnus thynnus*)

(For illustration see Color Plate, page 45)

Few fishes have a wider distribution than the

Tuna, for it is found in all warm seas. It is pelagic in its habits and occurs as far north as Newfoundland. It is the Tuna of California and the Mediterranean, the Tunny of the British Isles, the great Albacore, or Horse Mackerel, of our Atlantic waters. It belongs to the Mackerel family, of which it is the largest representative. On the North Atlantic coast, where Tuna are caught from early summer to October, they are large and numerous. During one season a single fisherman harpooned 30 of them with an average weight of 1,000 pounds. Some weighing 1,500 pounds have been taken. They also are caught on hooks baited with Herring attached to heavy lines.

The European varieties do not attain such size, 500 pounds being considered about the upper limit of their weight. On our California coast they are still smaller.

It is on this coast that they are considered the game fish *par excellence*. Charles F. Holder once observed that, weight for weight, the Tuna has double the fighting power in it that the Tarpon possesses. He called it the tiger of the California coast, a living meteor that strikes like a whirlwind and plays like a storm.

In American Atlantic waters the Tuna is found from Nova Scotia to Cape Cod. It feeds on Herring, Menhaden, and Bluefish.

SHAD (*Alosa sapidissima*)

(For illustration see Color Plate, page 46)

The Shad belongs to the Herring family and is an anadromous fish, spending the spring months in the rivers, where it spawns, and the rest of the year in deep-sea waters. On the Atlantic coast it enters all rivers between the St. Johns in Florida and the St. John in New Brunswick. Thanks to the good work in artificial propagation of the United States Bureau of Fisheries, Gulf of Mexico and Pacific coast rivers also know this delectable food fish to-day.

Formerly Shad were surprisingly abundant; but they have to be taken at spawning time, since they are not within reach of human hands at any other season; therefore they are especially liable to extinction by overfishing. Were it not for protective laws and artificial propagation, they would probably have disappeared almost entirely before now. The success of artificial propagation is shown by the fact that the Shad has been established along 2,000 miles of shore line on the Pacific where it never existed before, and that it remains, in spite of the heavy toll of overfishing, next to the Chinook Salmon, the most important river fish in America. But even with artificial propagation the catch has been diminishing at an alarming rate, having fallen off from 50,000,000 pounds in 1898 to less than one-half as much in a recent year. Overfishing, the placing of dams across many rivers, and water pollution have been responsible for the decrease.

The Shad does not appear to be a migrant from warmer to cooler waters with the advent of spring, as was formerly supposed. Rather, it seems to go out to the deep sea off the mouths of the several rivers it spawns in, and to remain there until the temperature of the river waters rises to about 60 degrees. The Shad in southern rivers has black-tipped back and tail fins, which is a mark absent in those visiting northern rivers.

The young fry, hatched out in the rivers, stay



Photograph by Christian W. Feigenspan

TOWING AN 800 POUND TUNA TO PORT

until the water falls below 60 degrees in the autumn, and then go out to sea and are not seen again until they enter the rivers to spawn, which is believed to be when they are three or four years old. The spawning Shad like to find water above 60 degrees, and go up the rivers, but the half-grown ones, preferring cooler water, stay behind. In 1882 there was a very late spring, the water not reaching 60 degrees until after spawning time. It was noted that the half-grown accompanied their elders to the spawning grounds that year.

During the spawning season the mature Shads seem to take no food at all. Their young, after hatching, feed on small crustaceans and insect larvæ until they go out to sea. The fact that the adults will rise to a skillfully placed fly at times indicates that their abstinence is due more to their impulse to hasten to spawn than to their lack of desire for food. They are a very prolific fish,

yielding as high as 150,000 eggs a season. The roe of no fish is more delicious than that of the Shad, and a planked Shad garnished with roe and bacon is as much a delight in the Nation's Capital in 1923 as it was in the days of Mt. Vernon and Marshall Hall, when the Father of his Country and the Laird of Marshall Hall were friends.

The Shad sometimes attains a length of more than 2 feet and a weight of 14 pounds, but the average weight has been falling as the decades have come and gone, until now it is probably under 4 pounds.

ALEWIFE (*Pomolobus pseudoharengus*)

(For illustration see Color Plate, page 47)

The Alewife is a species of Herring abundant in North Atlantic waters, possessing many vernacular names. In some places it is known as the Branch Herring, in other localities as the Blear-eyed Herring, and elsewhere as the Wall-eyed Herring and the Gaspereau. It is found on our Atlantic coast from the Carolinas northward, in Lake Ontario, and in some of the small New York lakes tributary to the St. Lawrence. Like the Shad, it goes up into the rivers to spawn, preceding that fish by two to three weeks.

Those Alewives that have become land-locked in fresh water are greatly dwarfed in size. In Lake Ontario many millions die every summer.

Another species, so closely related that for a long time it was not differentiated from the Branch Herring, is *Pomolobus æstivalis*, known in New England as the Summer Herring and in other localities by such names as Glut Herring, School

Herring, Blueback, May Herring, Kyack, and Blackbelly.

It is found from St. Johns River, Florida, along the entire Atlantic coast of the United States and the British Maritime provinces. The great centers of abundance are Albemarle Sound and Chesapeake Bay, where it is known as the Glut Herring, this term having reference to its abundance, which frequently leads to a glutted market.

The circumstances under which the two species were differentiated form a tribute to the keen-eyedness of Potomac fishermen. The attention of the zoölogists of what was then the Fish Commission was first called to the probable existence of the two species by the persistent opinions of the fishermen of the Potomac, who recognized two forms, differing somewhat both in habits and in appearance. These two forms they called respectively the Branch Herring and the Glut Herring.

The first announcement of the discovery of the existence of two species and the definition of their respective characteristics was published in a report of the Virginia Fish Commission for 1879. Goode remarks that, although the coast fishermen of Massachusetts and Maine claim to distinguish between the Alewives and the Bluebacks, their judgment is by no means infallible, since, when he had finished sorting them out into two piles, the fishes which they distinguished under these names were not at all accurately classified.

Like the Shad, both the Branch Herring and the Glut Herring are anadromous in habits. The dates of their first appearance in any given river closely agree with the movements of the Shad. The Branch Herring usually precedes the Shad by a fortnight or so and the Glut Herring comes about the middle of the Shad season.

Little is known of the food of the river Alewives and of their salt-water habitat, although it is believed that they, like the Shad, feed largely on living crustaceans. In the rivers they seem to eat very little.

They spawn after entering fresh water—the Branch Herring when the temperature has reached 55 to 60 degrees Fahrenheit and the Glut Herring when it attains 70 to 75 degrees.

The late Professor Baird regretted the absence of effort to restore the Alewife to its primitive abundance, and declared in one of his reports to Congress that the Alewife is in many respects superior in commercial and economic value to the Herring. He noted that it is a much larger and sweeter fish than the Herring, being more like the Shad. He attributed the diminution of the Alewife supply to the erection of dams and other barriers, and expressed the belief that the gradual wearing down of the Cod, Haddock, and Hake fisheries along the American coast is due more to the diminution of the Alewife supply than to any falling off in the number of sea Herring as food for these fishes.

HERRING (*Clupea harengus*)

(For illustration see Color Plate, page 47)

The Herring family includes not only the Herrings, but also the Sardines, the Alewives, the Shads, and the Menhadens.

Distributed throughout the entire North Atlantic Ocean, the Herring, *Clupea harengus*, is probably the most important food fish in the world.

With so many other species in competition, the Herring has never attained the popularity on American dinner tables that it has on those of Europe, where it forms a staple diet for millions; but even in our waters it is widely taken north of Cape Cod. Most of the fish are sold fresh, either for human food or Cod bait. Immense quantities of the young ones are packed and sold as Sardines.

Years ago Professor Huxley estimated that three billion Herring were being caught annually. With the growth of the fishing industry in European waters, it has been estimated that the annual catch now exceeds ten billion. A single shoal sometimes covers six square miles and is estimated to contain at least half as many Herring as the whole world catches in a year. Many such shoals are known to exist.

The Herring, unlike most fishes, is particularly fine-flavored at spawning time, and the fisheries are carried on busily during that season. Usually

the Herring is taken with gill nets anchored below the surface of the waters, in which so many are sometimes enmeshed as to sink the buoys. Other forms of taking it are by means of weirs and torching. The latter is particularly resorted to when cold weather sets in. A torch is set in the bow of the boat. The fish rise to the surface as the vessel glides swiftly along, and are scooped in without difficulty.

The food of the Herring consists principally of "red feed" and Shrimp. They are in turn preyed on by a list of enemies as long as the moral law, ranging from finback whales, porpoises, and seals to Cod, Dogfish, and Squids.

When schools of enemy fish attack the Herring the sea gulls are always on the job to gather up the scraps of the fray.

The life history of the Herring has never been completely worked out. The facts known indicate that it lives in deep water off the coasts, coming inshore to spawn. There seems to be a number of distinct races, differing as to size, spawning time, and various other qualities and traits, each race swimming in a separate school and having its own particular time and ground for spawning. The number of eggs laid by a female ranges from 10,000 to 50,000, it is said.

TAUTOG (*Tautoga onitis*)

(For illustration see Color Plate, page 48)

The Tautog is a species of the Wrasse family, stockily built, with a range from New Brunswick to the Carolinas. North of New York it is called the Tautog, while New York knows it as the Black-fish. Farther south it is called the Oyster Fish. The average weight is about three pounds, though occasionally one is taken weighing as much as 22 pounds. It has hard scales, a hard mouth, and a slipperiness that is eel-like.

The Tautog's food consists mainly of hard-shelled Mollusks, Squids, Scallops, Crabs, Barnacles, and Sand Darters. It eats them, shells and all, and then regurgitates the indigestible parts.

Close relatives of *Tautoga onitis* are El Capitan, or the Hogfish, of Florida waters and the Fatheads or Redfishes of the southern California coast.

All of the Tautogs belong to the Wrasse family, *Labridæ*, which is one of the largest known, including some 450 species, divided into about 60 genera.

BUTTER-FISH (*Poronotus triacanthus*)

(For illustration see Color Plate, page 49)

The Butter-fishes form a large group of small fishes, many famous for the fine quality of their flesh. *Poronotus triacanthus* is known as the Dollar-fish in Maine, the Butter-fish in Massachusetts and Norfolk, the Pumpkin Seed in Connecticut. It is a summer visitor, appearing and disappearing with the Mackerel. It has the habit of accompanying, in groups of ten or twelve, the Sun-squall Jelly-fishes in the inshore waters of the Middle Atlantic, seeming to seek shelter from its enemies under the Sun-squall's disks, or possibly finding there a diet of the soft-bodied invertebrates that are constantly becoming entangled in the tentacles of the Jelly-fish. But its position is not always a safe one, since it sometimes is lassoed in these same tentacles and eaten by its host.

The Harvest Fish (*Peprilus paru*), which ranges from Cape Cod to Brazil, but is especially abundant off the Virginia capes, is another member of



Photograph by H. Armstrong Roberts

DRYING NETS NEAR THE VIRGINIA CAPES

Important industries have arisen from the by-products of American fisheries. One of the oldest is the fish-scrap industry, utilizing the offal for fertilizer and for chicken and cattle food. Fish oils, used in the manufacture of cheap soaps, lubricants, and paints; Cod-liver oil, valuable medicinally; North American isinglass, used in clarifying certain beverages, in making adhesives, India ink, and a sizing for textile goods; glues and cements, are other by-products. Last year workers in Toronto University discovered that "insulin," prepared from the pancreas of the Shark, was useful as a palliative for diabetes.

the Butter-fish family. It reaches a length of 10 inches, and has the peculiar habit of swimming under the Portuguese Man-of-War, probably gathering the scraps that fall from the table of that fish, as well as enjoying protection from its enemies.

The Poppy Fish (*Palometa simillima*) found on the sandy shores of California is a close duplicate of the Dollarfish, and the San Francisco epicure pays a high price for it, supposing it to be Pompano, though admitting that the Pompano of the Florida coast has a finer flesh and better flavor.

SCUP (*Stenotomus chrysops*)

(For illustration see Color Plate, page 49)

The Scup belongs to the Porgy family, which also includes the Porgies and the Sheepsheads. The Scup (*Stenotomus chrysops*) ranges between Cape Cod and the Carolinas. It is the Scup in New England, the Porgy in New York, and the Fair Maid farther south, getting back to the Porgy again at Charleston. New Englanders often call it the Scuppaug, a corruption of the Narraganset Indian name, Muscuppanog. As a food fish it is one of the commonest and is highly esteemed for its flavor. A bottom-feeder, the Scup's diet is largely made up of Mollusks, small crustaceans, and worms. Along the South Atlantic coast the Scup is replaced by a closely related species *Stenotomus aculeatus*.

ATLANTIC SALMON (*Salmo salar*)

(For illustration see Color Plate, page 50)

Eighteen hundred years ago Pliny wrote that the Salmon surpassed all the fishes of the sea in the river Aquitania. That is the earliest allusion to *Salmo salar* known in literature, and although scores of other species have been identified, still *Salmo salar* is the Salmon outside of the canneries of the Pacific, which utilize other species.

The species inhabits both sides of the Atlantic and ascends the rivers as far as it can go in the spawning time, going up the St. Lawrence and through Lake Ontario to Niagara Falls.

At least half the Salmon's life is spent in the ocean, recalling Izaak Walton's remark that "he is ever bred in fresh rivers and never grows big but in the sea. . . . He has, like some other persons of honor and riches which have both their winter and summer houses, the fresh water for summer and the salt water for winter to spend his life in."

The Connecticut River once teemed with Salmon, but dams exterminated the species therein. The same fate has befallen them in many other rivers.

The young fish stay in fresh water for one or two years, and then wander out to sea, although they weigh only a few ounces when they go. There they find congenial food and grow rapidly. In that pleasant environment they remain until summoned, as Dr. Goode says, by the duties of family life to return to the narrow limits of the old home. When they live in the lakes they prey on Minnows and other small fishes, but those of the sea delight also in small crustaceans and crustacean eggs, to which they are said to owe the vivid color of their flesh. The habits of successive generations become hereditary traits and the differences in their life histories are held by many authorities to

justify the belief that the land-locked Salmon is merely a variety of *Salmo salar*.

Although the Salmon, like the Trout, spawn with a falling temperature, not depositing their eggs before the water has dropped to 50 degrees, they seem to enter the rivers on a rising temperature. In the Connecticut they appear in April and May, in the Merrimac in May and June, and in the Penobscot in June and July.

Temperature changes do not influence the movements of the Salmon as much as those of other species. It is said that two-thirds of the colony belonging to a particular river may be found in it in any season. This high proportion is made up of half the colony, less than a year old, and the breeding fish, which remain in the rivers six or seven months after the spawning season.

When they leave the ocean, they first enter the brackish water at river mouths, where they remain for several weeks; then they start for the spawning grounds, which they usually reach in late summer. At the approach of the spawning season their trim shapes and bright colors disappear, leaving them lank and misshapen, with fins thick and fleshy and skin slimy and blotched. This transformation takes place especially in the males. The jaws become so curved that they touch only at the tip, the lower of which develops into a large and powerful hook, used as a weapon in the savage combats which they stage with their rivals.

When the newly hatched Salmon appear they are about three-fourths of an inch long and the yolk sac is visible on them for from four to six weeks. When this is absorbed the youngling begins to feed, readily seizing any minute floating object. In two months it has grown to one and one-half inches and begins to assume the vermilion spots and transverse bars which it retains until it begins its descent to the sea, when it adopts a uniform bright silvery coat. After remaining in the sea for a period of from 4 to 28 months, it heads back to land, and then dawns the time that every fisherman loves, for at this stage nothing in the water surpasses it in symmetrical beauty, brilliancy, agility, and pluck. Christopher North has called it "a salmon fresh run in love and glory from the sea. . . . She has literally no head; but her snout is in her shoulders. That is the beauty of a fish, high and round shoulders, short waisted, no loins, but all body and not long of terminating—the shorter still the better—in a tail sharp and pointed as Diana's, when she is crescent in the sky."

SWORDFISH (*Xiphias gladius*)

(For illustration see Color Plate, page 51)

The Swordfish ranges in Atlantic waters from Cuba to Cape Breton. The extent of its range is attested by the fact that the Dutch call it the *Zwaard-fis*; the Italians, *Sofia*; the Spaniards, *Espada*; and the French, *Epée de Mer*. Aristotle named it *Xiphias* some twenty-three centuries ago. It rivals the Sharks both in size and strength, sometimes reaching a weight of 800 pounds, although most of those caught weigh less than half as much. It usually appears on the shoals and banks in June and stays until the colder fall months set in. It is believed to come out of the deeper waters in search of food, since its spawning grounds are not in shallow regions. It apparently follows the Menhaden and Mackerel. Old fishermen have a saying that where you find Mackerel you may



FULL TO THE GUARDS

Of the myriad forms of fish life, one of the largest groups is that of the bassalian, or deep-sea fishes, which includes those that live below the line of adequate light. Since they dwell below the influence of the sun's rays, climatic zones and surface temperatures have little relation to them, and the same forms are to be found in the Arctic as under the Equator. These deep-sea fishes are held to be adaptations of forms that once lived close to shore.

expect Swordfish. When swimming near the surface, it usually comes so close to the top that the tips of its back and tail fins are exposed.

This exposure enables the fisherman to detect its presence, and, being given to swimming slowly at times, it is easily overtaken by a schooner with a light breeze to drive it. Every now and then it leaps entirely out of the water, and old fishermen attribute this to tormenting parasites; but modern authorities disagree with that theory. Be that as it may, one authority tells us that it strikes with the force of fifteen double-hammers and with the velocity of a swivel shot.

Its stupidity in attacking ships and other objects sailing the seas is so great that Oppian tells us that "Nature her bounty to his mouth confined, gave him a sword, but left unarmed his mind."

The feeding habits of the Swordfish are striking. It is said that it swims under a school of small fishes, and then, suddenly rising to the top, thrashes about with its sword, killing a number of its prey in the act. These it promptly devours and then repeats the performance.

It is said the Swordfish never comes to the surface except in moderate, smooth weather. Once it is sighted the lookout at the masthead "sings out," and the skipper takes his place in the "pulpit," on the end of the bowsprit, holding the harpoon pole in both hands by the small end. Directing the helmsman, he guides the vessel toward the quarry, and when the fish is eight or ten feet off the prow, rams the harpoon into its back. The fish is allowed plenty of line, and then two men go out in a yawl and maneuver the victim alongside, where it is killed with a whale lance.

There are some of the thrills of whaling in sword-fishing, since there is no slow baiting or careful waiting and no bother with nondescript bait-stealers. The Swordfish is a worthy antagonist, and many a vessel has limped into port, leaking badly as a result of attacks by wounded Swordfish. Occasionally a small boat is attacked and the sword rammed clear through its side. Once the sword punctured two inches into the heel of a sailor standing in a boat.

SMELT (*Osmerus mordax*)

(For illustration see Color Plate, page 52)

The Smelts are structurally akin to the Salmon, being largely like them except in size. The other chief difference is in the form of the stomach, which, in the Smelts, is a blind sac, with the two openings close together, while in the Salmon it is siphon-shaped. All of the species are small and most of them stick strictly to the sea, although a few go up rivers to spawn, after the fashion of the Salmon. All of the abundant species are edible, the flesh being extremely delicate and often full of a fragrant, digestion-aiding oil.

The leading American Smelt is *Osmerus mordax*, a shapely little creature that is rarely longer than 10 inches. It ranges along the coast from the Virginia Capes to the St. Lawrence Gulf, and enters the streams and brackish bays to spawn during the winter months, when it is taken in great numbers, with hook and line and in nets.

In going up streams some of the Smelts have lost their way and become landlocked in numerous lakes such as Champlain and Memphremagog.

The fishermen take vast quantities of them during the winter, most of which are frozen and sent

to the larger cities. Those that are not frozen are termed Green Smelts and are rated very high on the scale of finely flavored fish. Shrimps and other small crustaceans form the favorite food of this species.

Captain John Smith, of Jamestown fame, wrote in 1622 that there was such an abundance of them that the Indians dipped them up from the rivers with baskets used like sieves.

Another Smelt that belongs in the fine-food category is the Capelin, found from Cape Cod to the Arctic on the Atlantic coast and in Alaskan waters on the Pacific. Its eggs are deposited in vast quantities in the sands along the shore. These, washed up on the beaches, present the appearance of masses of little fishes, eggs, and sand. Hatching takes place in about thirty days, and the youngsters ride the first waves out into the sea.

Still another Smelt that meets with favor wherever it abounds is known as the Eulachon, or Candlefish (*Thaleichthys pacificus*), which lives in great numbers on the Pacific coast from Oregon northward. It is said to be unsurpassed in delicacy of flavor, which is described as exceeding that of any Trout. It is remarkable for its extreme oiliness, which is so great that, when dried and a wick put into its body, it serves as a candle; hence its name. The oil is sometimes extracted and used as a substitute for cod-liver oil. At ordinary temperatures it is solid and lardlike in its consistency.

TILEFISH (*Lopholatilus chamaeleonticeps*)

(For illustration see Color Plate, page 53)

There is no greater wonder story of the seas than the history of the Tilefish. To-day a few connoisseurs pronounce it second only to the Pompano in flavor, and it is receiving much attention from those who are not Bourbons in matters of food.

Prior to 1879 this fine fish had no place in the roster of known fishes. In that year a New England trawler, fishing for Cod off the Nantucket coast, took 5,000 pounds of Tilefish, the first of which there is any record. Whether eaten fresh, salted, or smoked, the samples the trawler took home proved attractive.

For three years there was widespread interest in this newly found food fish. Then, in April and May, steamers arriving from Europe reported seeing myriads of dead Tilefish. One steamer reported that it had sailed through 150 miles of them, and data gathered indicated that perhaps 7,000 square miles of sea surface was strewn with the victims of some untoward circumstances of the sea. It was estimated that the total number of dead fish might reach a billion and a half.

There were no signs of disease and no evidences of parasitic infection. Neither could the calamity be accounted for on the basis of attack by other creatures.

All sorts of theories were advanced to explain the catastrophe—submarine volcanoes and poisonous gases among them.

It had been noted, however, that there was a strip of water, lying on the border of the Gulf Stream slope, between the Arctic current and the cold depths of the sea, which was warmer in 1879 and 1880 than the normal water of that region. Dredging in this water had revealed many species of marine invertebrates characteristic of the waters of the lower latitude, a sort of tropical faunal peninsula in the sea.

In 1882, after the vast schools of Tilefish had disappeared, this region was resurveyed. It was



SWORDFISH TAKEN IN CAPE BRETON WATERS

It has long been the opinion of ichthyologists that the Swordfish's spawning ground is in the Mediterranean Sea. The fact that small ones are constantly caught in the Mediterranean, but that only larger ones are taken in American waters, seemed to justify the conclusion that they did not spawn on this side of the Atlantic. But a small Swordfish weighing less than eight pounds has been taken near Boston and a female containing spawn landed at New Bedford. This evidence serves to reopen the question.



Photograph from H. L. Rust, Jr.

A "GIANT" LOBSTER THAT LOST ITS LUCK

Big fellows like the one here shown are probably not giants of their species, but merely those to whom fate was so kind as to allow them to grow to their full maturity. It may have escaped the perils of half a century before the luckless hour when it became enmeshed in some fisherman's gear.

found that the water was colder, and that the marine life that formerly occupied this thermal peninsula had disappeared. What had happened was that northern gales had driven Arctic ice down into the area and had made the water too cold for the Tilefish to bear.

It was predicted that if this were the correct explanation, and if the water came back to its usual temperature again, the Tilefish would ultimately reappear. But years went by and not a single survivor of the catastrophe was found. Fears began to be entertained that the species had been wholly exterminated by the calamity that had befallen it.

But in 1892 the *Grampus* caught eight. Increasing catches with successive years showed that the Tilefish was gradually reestablishing itself, just as the scientists had predicted it would.

But after the Tilefish appeared again the task arose of introducing it to the dining table of the American people. Possessed of a flesh of fine texture and good flavor, the difficulty lay only in the inertia of the people against trying new kinds of food. The Bureau of Fisheries, however, undertook propaganda in favor of the Tilefish and met with fair success. For awhile it was the most advertised fish in American waters. At present it has to rely on its own flavor to carry it to a wider and disinclined-to-try-new-things clientele.

AMERICAN LOBSTER (*Homarus americanus*)

(For illustration see Color Plate, page 54)

The American Lobster is an edible crustacean found on the coasts of the North Atlantic Ocean

and the Mediterranean Sea—on our coast especially from Delaware to Labrador. It inhabits waters from the shore out to the 100-fathom line and is most numerous on the shores of Maine and Nova Scotia. It prefers rocky bottoms, though it may be found in other environments, and usually, though not without exception, leaves the shallower waters during the winter months and finds temperatures more to its requirements beyond the 100-fathom line.

All kinds of animals, both living and dead, and some vegetable matter are pleasing to its appetite. Although dangerous prey to attack, the Lobsters, in spite of their hard shells, powerful claws, and burrowing habits, fall victim to the Cod, the Tautog, the Skate, and the Dogfish, which annually destroy millions of them, particularly the young ones, the egg-bearing females, and the molting adults.

The effect of overfishing for Lobsters shows more in the steady decline in the size of those taken than in the diminution of numbers. The provision of a closed season does not accomplish much, since the female carries her spawn attached to her body for about ten months. Regulations requiring the release of females carrying spawn—"in berry," as that condition is known to the Lobster fishermen—have been made, but are usually ineffective.

The number of eggs produced by a female Lobster varies from 3,000 to 100,000, depending upon the size and age of the individual, maturity being reached in from three to four years. It is believed that it lays only every other year.

The Lobsters are usually caught in traps known as Lobster pots, made of ordinary plastering lath and having a funnel-shaped opening made of tarred



Photograph by E. R. Sanborn, New York Zoological Society

A SHARK AND HIS DEADHEAD PASSENGER

Evidently nature intended the Remora, or Shark Sucker, to be a sort of sea jockey for its head is equipped with a suction disk, or vacuum cup, that gives it a unique advantage. It can attach itself at will to the body of the Shark, Turtle, Porpoise or Swordfish and thus as a passenger tour the seas. The Shark does not seem to object particularly to its "excess baggage" and the Remora lives largely upon the scraps of food that fall from the jaws of his benefactor as the latter feeds. Darting from his riding seat, the Remora seizes his morsel and returns like a flash atop, on the flank or beneath the Shark. Mr. Sanborn's remarkable photograph shows the deadhead passenger traveling around the aquarium tank awaiting meal time.

netting, permitting easy ingress, but closed against exit. The traps are sunk on Lobster-frequented grounds and baited usually with pieces of stale fish. The European Lobster is nearly always sent to market in the fresh state, while many of those

caught in American waters are canned. The European variety seldom reaches a weight of 10 pounds, while those of our shores occasionally weigh as much as 25 pounds. The largest one ever taken, according to the records, weighed 34 pounds.

Prominent Species of the Middle Atlantic Coastal Waters

Out of the waters of Chesapeake Bay and the Middle Atlantic coast from the Carolinas to Cape Cod come annually thousands of tons of well flavored fish for American tables. No fish as staple as the Cod of the Grand Banks and no fighter that quite ranks with the Tarpon of Florida waters, is found along the middle coast, but none the less, its representatives are leading favorites in the big markets of Washington, Baltimore, Philadelphia and New York and scores of smaller inland places to which they are shipped daily in refrigerator cars.

Three familiar varieties alone, the Squeteague or Weakfish, Striped Bass, and Bluefish, provide about 21,000,000 pounds of food annually. The gamy Squeteague, which ranks chief in quantity, is well and favorably known to the sport fisherman and will put up an excellent fight when hooked either in deep water or in the surf.

With the cold waters of the Labrador Current and the Gulf Stream's edge fusing along the Middle Atlantic coast, the fishes of this section have apparently adapted themselves to temperature change. Thus the Striped Bass and Mullet are found all up and down the east coast, but the chief quantities for market come from the Middle Atlantic region. The Bluefish, found in nearly all ocean waters, is obtained for American markets chiefly on fishing grounds from Long Island to Florida. Sea Bass, Kingfish or Northern Whiting, Sheepshead, and Bonito, are also among the "first families" of the Middle Atlantic coast species and much can be said for them, from the standpoint of both sport and table.

SQUETEAGUE (*Cynoscion regalis*)

(For illustration see Color Plate, page 72)

The Squeteague, also known as the Common Weakfish, is caught in large numbers along the Atlantic Coast between Massachusetts and Florida. In North Carolina it is found almost throughout the year, but is most abundant from early spring to late fall.

It first appears in large schools in April and May, appearing in various bays and sounds along the Atlantic Coast. A little later part of the fish migrate to the ocean to spawn and part accomplish spawning in the larger bays such as the Chesapeake. In the Chesapeake Bay region the first run of fish appears between April 1 and May 1, according to the water temperature. A heavy run of fish occurs until June. During the summer catches of commercial proportion decrease somewhat, yet, again in October good catches are made—especially of large fish. The last of the fish leave the Bay by about December 1, and are not found throughout the winter.

In this case spawning occurs from May to July, depending somewhat upon the latitude. Gravid males are frequently found until late August. The spawning takes place on the bottom; but as soon as the eggs are extruded and fertilized they float to the surface, and are carried about by the tidal currents until hatched.

While there are authentic records of Squeteague weighing 18 pounds being taken, and fisherman's stories of thirty pound ones, fish weighing as much as 12 pounds and measuring as long as 33 inches are uncommon.

Little is known about the migratory habits of the Squeteague. Whether it seeks warmer waters in its summer latitudes in the depths of the Gulf Stream or finds them in the southern ocean, is not known definitely to science.

In southern waters this species is known as the Sea Trout, or Gray Trout.

The annual catch of Squeteague in Atlantic waters ranges around 15,000,000 pounds.

A closely related species, the Spotted Squeteague, is an abundant and valuable fish found along the South Atlantic and Gulf coasts.

STRIPED BASS (*Morone saxatilis*)

(For illustration see Color Plate, page 72)

This striking denizen of middle Atlantic waters has a range reaching from the St. Lawrence, in Canada, to Mobile Bay, Alabama; but in commercial quantity is most common between Long Island and Cape Hatteras. It ascends fresh water to spawn and is particularly common in brackish bays and rivers where it may be found throughout the year. It is equally at home in the sea where it spends a good part of its life. Its migrations differ from those of Shad, as the Striped Bass hibernates over the winter season and is found at this time in the lower Potomac River, and other suitable waters. There is a definite spring run when spawning takes place, but it may be caught throughout the year in Chesapeake Bay and Albemarle Sound, North Carolina.

As many as 1500, it is reported, have been taken at a single haul of a large seine. There are records of individuals being caught that tipped the scale's beam at 125 pounds. Heavy fishing, however, has changed all of this, so that a weight of 75 pounds is now rarely achieved. Most of the market catch weighs between 1 and 15 pounds, but fish weighing from 25 to 60 pounds are not unusual.

The Striped Bass is a rather long-lived fish. Several two year old specimens placed in the tanks of the New York Aquarium, when it was opened, lived there for sixteen years and one survived nineteen years.



Photograph by H. Armstrong Roberts

LANDING A SIX-POUND WEAKFISH, OR SQUETEAGUE, IN BARNEGAT BAY, NEW JERSEY

The Weakfish did not get its name from any lack of gameness, but rather from the softness of its mouth parts. At the end of a line and rod of sportsmanlike proportions it can give the fisherman who hooks it a battle that calls for all the resources of skill to bring it to the landing net.

Fish culture as applied to this species has richly justified itself. A number of small Striped Bass were taken from the Atlantic to the Pacific and placed in West Coast rivers over a quarter of a century ago. Today there are many millions of them in Pacific waters.

The catch of this species in Atlantic waters reaches nearly 2,000,000 pounds annually. On the Pacific Coast the annual catch amounts to about 1,000,000 pounds.

SEA BASS (*Centropomus striatus*)

(For illustration see Color Plate, page 73)

Feeding upon Crabs, Shrimps, small fish and Squids, the Sea Bass usually spends its time moving about sluggishly on the floor of the coastal waters or lying among loose stones and in rock cavities. It is found from Gloucester, Massachusetts, to Jackson-

ville, Florida. Its region of greatest abundance extends from Montauk Point, Long Island, to North Carolina, and it is rare north of Nantucket, Massachusetts.

While Sea Bass weighing as high as 7½ pounds have been taken, the average size of those landed is around 2 pounds. As a food fish it takes high rank, its flesh being distinguished alike for its flakiness and sweetness.

The spawning time of this species occurs in May and June.

The family Serranidae, to which the Sea Bass belongs, is one made up of a large number of species.

BLUEFISH (*Pomatomus saltatrix*)

(For illustration see Color Plate, page 74)

The Bluefish can boast of being in a class all by itself. It constitutes a family with a single species.

A cosmopolite of the oceans, it is found around the Malay Archipelago, Australia, Africa, the Mediterranean Sea and elsewhere, but is strangely missing on the Atlantic Coast of Europe and around Bermuda. It ranges from Maine to Texas, though found primarily from Long Island to the east coast of Florida, where it is caught from April to late October. It visits southern Florida waters only in midwinter. Traveling in great schools and attacking other fishes with a wantonness nowhere exceeded in the whole world of finny folk, Bluefish make Menhaden their principal food, and their abundance or scarcity depends largely on the annual crop of these Herring of the sea.

Professor Baird once called it unparalleled in its destructiveness, and another authority likened it to an animated chopping-machine whose business is to cut to pieces and destroy as many fish as possible.

More wanton than weasels, they travel in vast schools marking their trail with fragments of fish and stains of blood.

Like a pack of wolves, they attack everything in their path, killing many times as much prey as they can eat, seemingly from the sheer fun of killing.

Being of excellent flavor, the Bluefish has become one of America's most important food fishes, and always commands a relatively high price.

BONITO (*Sarda sarda*)

(*For illustration see Color Plate, Page 74*)

The Bonito belongs to that eminent family of fishes, the Mackerels. Among its cousins are the Common Mackerels, the Frigate Mackerels, the Tunnies, the Albacores and the Kingfishes.

It lives mainly in the open sea, widely wandering in vast schools and approaching land only in search of food or for spawning. Its summer range is from Cape Cod, Massachusetts, to Cape Sable, Florida; it is also found in the Gulf of Mexico. It sometimes reaches a length of from 2 to 3 feet, and a weight of from 10 to 12 pounds; but usually does not exceed 6 pounds.

The flesh of the Bonito often passes current as Spanish Mackerel, though it is far inferior to that fish in edibility.

The late Professor Goode called the Bonito a marvel of beauty and strength, and asserted that it is one of the ocean's fastest swimmers, being built on such fine stream-line proportions, and having such a polished-surface body that water resistance is brought down to negligibility. "The bonitoes," said he, "in our sounds to-day may have been passing Cape Colony or the Land of Fire day before yesterday," so fast can they glide through the water.

Over 2,000,000 pounds of Bonito are taken each year in American Atlantic waters.

MULLET (*Mugil cephalus*)

(*For illustration see Color Plate, page 75*)

The Striped Mullet for a long time ranking low in the list of food fishes, has recently become one of the most highly regarded, especially when eaten soon after being captured. No less an

authority than the late President Harding declared on his last trip to Florida that he found it an exceedingly palatable fish. It is the most valuable food fish caught along the south Atlantic and Gulf coasts.

Belonging to a family which includes the Lisita and the Dajao, it is quite cosmopolitan in its range, being found alike in the Atlantic and the Pacific, from Massachusetts to Brazil and from California to Chile. It likewise is found on the coasts of southern Europe and northern Africa.

Traveling in schools, the Striped Mullet is abundant in salt water or brackish water areas. It reaches a length of 30 inches and a weight of 10 pounds. In southern Florida fish 20 to 24 inches long are common, but in the northern part of its range it seldom exceeds 16 inches. It is not given to preying on other fish as are the Bluefish, for instance. Rather, it gets its nourishment by chewing mud and separating the small food particles therefrom. Naturally, therefore, it is a bottom feeder.

SHEEPSHEAD (*Archosargus probatocephalus*)

(*For illustration see Color Plate, page 75*)

The Common Sheepshead has a range that sweeps from Cape Cod, Massachusetts, to Corpus Christi, Texas, though it does not wander as far south as the West Indies. Once rather common, it is now rare north of Cape Henry, Virginia. It is found in greatest abundance between North Carolina and Texas.

Unlike so many other fishes, it does not travel in schools, but wanders about singly or in small groups. Crustaceans, Mollusks and sea plants are its favorite food.

The spawning season of the Sheepshead begins in February and lasts until May. The maximum weight is 30 pounds, though the average in the southern part of its range is from 2 to 5 pounds. In the Chesapeake Bay, where it is now uncommon, the usual size is from 5 to 15 pounds.

The Sheepshead belongs to the Porgy family. Among its cousins are the Scup and the Porgies.

It is one of the most important fish caught in the Gulf States, where one and a half million pounds are taken annually.

KINGFISH (*Menticirrhus saxatilis*)

(*For illustration see Color Plate, page 76*)

The Kingfish, locally known also as the Northern Whiting and Sea Mink, is found from Cape Ann to southern Florida. It reaches its greatest abundance in the northern part of its range. As a food fish it ranks high. The name Whiting also attaches to the Silver Hake, the Hogfish, and many other species.

This fish belongs to the Kingfish genus of the Croaker family (*Sciaenidae*), which family embraces the Weakfishes or Squeteagues, and Sea-drums.

Most closely related to it are such species as the Carolina Whiting, of the South Atlantic, and the Silver Whiting, of the Gulf coast. The California Whiting on the Pacific coast is another of its close relatives.



Hashime Murayama

Painted by Hashime Murayama

COMMON SQUETEAGUE (*Cynoscion regalis*) [at top]; STRIPED BASS (*Morone saxatilis*)

The Squeteague, also known as Weakfish, is caught along the Atlantic Coast from Massachusetts to Florida. It is a favorite in the Chesapeake Bay region. It spawns at the bottom but as soon as the eggs are extruded and fertilized they float to the surface and are carried about by the tidal currents until hatched. In southern waters this species is known as the Sea Trout. The Striped Bass, which ranges from the St. Lawrence to Mobile, Alabama, is anadromous like the Salmon. It ascends rivers and brackish bays to spawn. In commercial quantities it is most common between Long Island and Cape Hatteras. Fish culture has successfully placed millions of Striped Bass in Pacific waters.



Hashime Murayama

Painted by Hashime Murayama

SEA BASS (*Centropristes striatus*)

The Sea Bass usually moves sluggishly about the ocean floor feeding on Crabs, Shrimps, small fish and Squids. While it is found from Gloucester, Massachusetts, to Jacksonville, Florida, its region of greatest abundance is from Montauk Point, Long Island, to North Carolina. The average size of Sea Bass is two pounds.



Hashime Murayama

Painted by Hashime Murayama

BONITO (*Sarda sarda*) [at top]; BLUEFISH (*Pomatomus saltatrix*)

The Bonito belongs to the Mackerel family. It wanders in vast schools in the open sea, approaching land only in search of food and for spawning. The Bonito usually does not exceed six pounds. Fine stream lines and polished surface body enable it to be one of the ocean's fastest swimmers. Bluefish is a family with a single species. A cosmopolite of the oceans, it is found around the Malay Archipelago, Australia, Africa, the Mediterranean and all along the Atlantic and Gulf coasts. Bluefish are animated chopping machines and leave a trail of blood and scraps as the schools travel about.



Hashime Murayama

Painted by Hashime Murayama

MULLET (*Mugil cephalus*) [at top]; SHEEPSHEAD (*Archosargus probatocephalus*)

The Striped Mullet is the most valuable food fish caught along the south Atlantic and Gulf coasts. For a long time it was not popular but now it is highly regarded. Off Florida, Mullet grow to twenty to twenty-four inches but in the northern limits of their range seldom exceed sixteen inches. Averaging two to five pounds but attaining five to fifteen pounds in the Chesapeake Bay, the Sheephead is found from Cape Cod to Corpus Christi, Texas. Unlike other fishes it feeds singly or in small groups. The Sheephead is a member of the Porgy family.



Painted by Hashime Murayama

KINGFISH (*Menticirrhus saxatilis*)

The Kingfish, also known as Northern Whiting, Round Head, and Sea Mullet, ranks high as a food fish. It is a member of the Croaker family which embraces the Weakfishes and Sea Drums. It ranges from Cape Ann to southern Florida, but is caught in greatest numbers in the northern reaches of its range.

Our Heritage *of* the Fresh Waters

By CHARLES HASKINS TOWNSEND

Director of the New York Aquarium

SINCE the beginning of time mankind has been able to get some part of his food from the waters; among the relics of the Stone Age are shell hooks and stone sinkers. Ancient sculptures—Assyrian, Egyptian, and Aztec—portray the taking of fishes with spear, hook, and net.

The prophet Habakkuk—who knows how many centuries B. C.?—placed some details on fishing in the earliest literature: “They take up all of them with the angle, they catch them in their net, and gather them in their drag.”

In some of the far corners of the world amazingly primitive ways of getting fishes are still in use.

In the mountain streams of New Guinea the still-savage native has been found using a dip net made of a hoop fitted with a piece of unbelievably tough spider web.

We have seen the Aleut drag up a heavy halibut with a huge hook of bent wood, the Fuegian make a successful throw with his bone-pointed spear, and the Tonga islander stupefy hundreds of fishes with the juices of a poisonous plant.

The modern Japanese fisher has not yet lost the ancient art of making the *cor-morant* fish for him without the trouble of providing either hook or bait.

OUR FRESH-WATER FISH RESOURCES ARE CONSTANTLY DIMINISHING

In considering the resources of our fresh waters, we find everywhere exhaustive methods of fishing and a diminishing supply, in spite of restrictive measures and extensive fish propagation.

The means by which diminution is measured are to be found in the fishery statistics of the past half century. The annual yield of products—still very large—can be safely viewed only in comparison with the continual increase and improvement in the apparatus of capture.

It takes more and more gear to make the same catch. In the Great Lakes, our

largest reservoirs of fresh water fish food, the investment in the fishery industry now exceeds \$10,000,000. The principal fish-catching devices, such as pound nets, fyke nets, and gill nets, practically automatic in operation, are filling day and night as long as the Lakes are free from ice.

The rivers and lakes of the United States have fishery resources that are unequaled elsewhere. The Great Lakes are virtually inland seas and the navigable rivers are among the largest in the world. The mighty Mississippi, with its tributaries reaching in all directions, fairly dominates the map of the country.

These waters, with the rivers of the Atlantic and Pacific coasts and many lakes of the Northern States, have been enormously productive in food for our people.

TONS OF FOOD FROM GREAT LAKES

In one year commercial fishermen alone have taken from the Mississippi River and its tributaries more than 96,000,000 pounds of fish, while the Great Lakes yielded more than 113,000,000 pounds.

Large as are the food supplies of these two regions at the present time, they must have been vastly greater before the exploitation of their resources began. Unfortunately, there are no official records by which the extent of the earlier fishery operations may be measured.

While the fish food derived from our fresh waters is vast in quantity, it is also notable in variety. There are many kinds of Trouts, Salmons, Whitefishes, Sturgeons, Pikes, Basses, Sunfishes, Perches, Catfishes, the Shad and the Eel, as well as the less important, but abundant and widely distributed, Chubs and Suckers.

In addition to the familiar food and game fishes, our waters are rich in Minnows, Darters, Shiners, and other small fry of no direct economic value, but of vast importance as the food supply of larger fishes. Every great watershed has



Photograph by William H. Zerbe

ON HIS WAY TO THE HUNTING GROUND OF YOUTH



© Haynes, St. Paul

CATCHING YOUR FISH AND COOKING IT WITHOUT MOVING FROM YOUR TRACKS

The Yellowstone Trout (*Salmo lewisi*) is very abundant in Yellowstone Lake, Yellowstone National Park. The "boiling pot" is one of the numerous hot-water holes to be found in this region. The surrounding water is cold.

its peculiar forms of these, all well known to ichthyologists, who have described and named them by the score.

Some of our smallest fishes have been found useful in combating malaria and annoyance caused by mosquitoes, and are even being shipped by the United States Bureau of Fisheries to mosquito-plagued foreign countries. There is now in progress much active investigation regarding the value of several species of fishes for the control of the mosquito.

UNITED STATES HAS FIVE TIMES AS MANY KINDS OF FISHES AS EUROPE

The richness of fish life in our fresh waters is amazing. The United States has a smaller area than Europe, yet it has nearly five times as many kinds of fresh-water fishes. We have about 585 species of these, while Europe has but 126 species.

We find that a single State may have considerably more than 100, the number known to Illinois being 150, while New York is credited with 141. It could doubtless be shown that our fresh-water fish-

ery resources are greater than those of any other country.

Many of the fishes commonly taken for food or in sport fishing, and naturally of wide distribution, have, as a result of fish-cultural operations, been established in sections of the country far removed from their original habitat.

A fish belonging to the Mississippi system or to the Atlantic slope often takes full possession of a new watershed, as the result of mere trans-plantation of limited numbers.

Although the numbers of fishes caught by anglers do not figure in statistics of the catch made for market, they are not without high economic and other values. Most of the Northern States are visited in summer by tourists interested primarily in good angling waters.

Lakes far and wide have become summer resorts for people who find much of their recreation in fishing. Railways and summer resorts widely advertise the resources of their waters. Summer visitors, moving actually by hundreds of thousands, carry into these States millions



FISHING IN SKYKOMISH RIVER NEAR INDEX, WASHINGTON

There are several kinds of Trouts in the waters of Washington State, mostly the "Cutthroat" forms, which are more numerous in the Rocky Mountain region.

of dollars. The trade in angling equipment alone is extensive.

Who can measure the health and esthetic values attendant upon the angling idea? Some one has recently asserted that the angling habit is conducive to long life, and, beginning with Izaak Walton, who lived to be ninety, presents a lengthy list of celebrated fishermen who lived well into the eighties and nineties, many of them prominent in the literature of American angling.

Fresh-water fish culture in the United States has been carried on for more than fifty years in steadily increasing volume, in the effort to keep pace with a depletion by fishery industries that constantly threaten exhaustion of the fish supply.

POLLUTION A DANGEROUS MENACE

The great fishery problem of the time in our country is the pollution of the fresh waters by innumerable agencies, rapidly affecting their productiveness. Unless stern measures are introduced by law to correct this, soon one of our great natural economic gifts will be seriously stricken.

When we consider that the market catch in the Great Lakes alone sometimes exceeds 100,000,000 pounds a year, that legions of anglers are overfishing the Trout and Bass streams everywhere, and that pollution of the rivers by manufacturing industries has reached appalling proportions, it is apparent that our heritage of the waters is endangered to a serious degree.

Fish culture alone cannot save it, even if greatly increased. We are already



Photograph from U. S. Bureau of Fisheries

THE MAGNIFIED SCALE OF A DOG SALMON

This scale was taken from a mature male in its fourth year. Note the "rings," like those of the cross-section of a tree, by means of which the age of a fish can now be computed.

wasting expensive propagation work in stocking waters no longer suitable for fish life, and many streams have been abandoned to their fate. One could name a score of rivers in mining and manufacturing States, once contributing to the food supply, that now contain no living thing—no fish or Mussel or Crayfish, not even the air-breathing Frog. These rivers represent damaged resources and there are others that may soon be like them.

Reforms come so slowly that the great cleaning-up task ahead of the American people is not likely to be undertaken seriously until conditions become intolerable.



© Roland W. Reed

THE "FISHING ROD" OF THE OJIBWAY INDIANS OF NORTHERN MINNESOTA

Most of the northern tribes of Indians are adepts with the fish spear.



Photograph by Eugene J. Hall

FISHING IN THE GORGE BELOW NIAGARA FALLS

The Great Lakes constitute a vast inland reservoir of fish life, the annual commercial catch sometimes exceeding 100,000,000 pounds.

In many countries all wastes available for fertilization are restored to the land and not sent insensately through sewers into the streams, while manufacturing wastes are converted into valuable by-products. The exhaustion of our fresh-water resources through overfishing and water pollution is not inevitable. There is now a saving fund of knowledge relative both to propagation and protective measures, awaiting application through the force of aroused and insistent public demand.

A more recent but increasing danger to which angling waters are exposed lies in

the ever-increasing use of the automobile. Bass and Trout waters heretofore reached with difficulty have become the easily accessible resorts of camping parties, with the result that their resources are being exhausted.

Many as are the sportsmen taking toll of our wild life with the gun, those who use the rod are vastly more numerous. It is as easy to exhaust a small stream by overfishing as it is to exhaust the quail supply of a neighborhood. Fortunately, the preservation of the fishes is always possible through the employ-



Photograph courtesy Noa Spears, © C. O. Lee

A CANNIBAL BASS FALLS A VICTIM TO HIS APPETITE

These two fish were picked up by a boatman while they were still struggling in Medina Lake, near San Antonio, Texas. The large Bass had the entire head of the smaller Bass in his mouth. Hungry Bass sometimes try to swallow fishes larger than they can manage comfortably, even their own species. The cannibal shown above is the Large-mouth Black Bass. Like the Pickerel, he can digest a particularly large mouthful by inches.

ment of safeguards and restorative measures. Our fishing will doubtless last longer than our shooting.

Private fish culture would be of great service in maintaining and increasing our supply of fish food. While it has been practiced for centuries in some European countries, it has but little more than commenced in America.

The possessors of strongly flowing springs, brooks, and small lakes should be awakened to the value of their home resources for water farming. Approved methods for the construction and management of fish ponds have been worked out at public fish-cultural stations and instructive public documents on the subject can be had for the asking.

Fish-culturists assert that an acre of water can be made to yield more food than an acre of land and the truth of the assertion has been demonstrated.

MUSSELS DEPENDENT UPON FISH HOSTS

An interesting work in aquiculture is now being carried on in the Mississippi Valley under the direction of the Bureau of Fisheries. It is based upon the fact that the propagation of the Mussel is dependent upon the presence of fishes to which the young, free-swimming Mussels may attach themselves as parasites until they are old enough to form shells and begin an independent existence.

The large, heavy-shelled Mussels of this region have been gathered in such numbers for the manufacture of pearl buttons, and also for the valuable pearls they sometimes contain, that the supply is being exhausted and the important industry dependent upon the Mussel is in danger.

The Mussel industry annually yields 60,000 tons of shells which are worth more than \$1,000,000. We are all wearing pearl buttons from this source, which will be missed if the great river becomes too foul for the growth of Mussels.

Young Mussels attach chiefly to the gills of fishes, and in some species



Photograph by Scenic America Company

FISHING IN CRATER LAKE, CRATER LAKE NATIONAL PARK, OREGON

There were no fishes in Crater Lake until Rainbow Trout were introduced by the Government. Crater Lake is six miles long, four miles wide, and in one place 2,000 feet deep. Its surface is 6,000 feet above sea-level, its steep walls rise from 500 to 2,000 feet above its surface, and it has neither inlet nor outlet that has yet been discovered.



Photograph by R. R. Sallows

RIGHT OUT OF COLD STORAGE

Breaking winter's seal on fishing waters is a well enjoyed sport of fishermen in the northern tier of states. The many small glacier-dug lakes freeze over although the Great Lakes seldom gather a coat thick enough to permit fishing through the ice. This style of fishing is common among the Eskimos.



Photograph by E. R. Sanborn, New York Zoölogical Society

YOUNG SMALL-MOUTH BLACK BASS WINTERING IN AN AQUARIUM

The fish remain poised in mid-tank, crowded closely together. As long as plants can be kept growing in the cold water the fish will pack themselves tightly among them. While the temperature of the water remains low, the fish seldom take food.

to the fins, during the early period of their lives. It is now practically certain that all Mussel spawn which fail to find a suitable fish host sink to the bottom and die.

The young Mussels are temporarily provided with minute hooks for attachment and are soon enveloped in the epithelium of the fish, where they remain encysted until the shell begins to form and they can safely drop off.

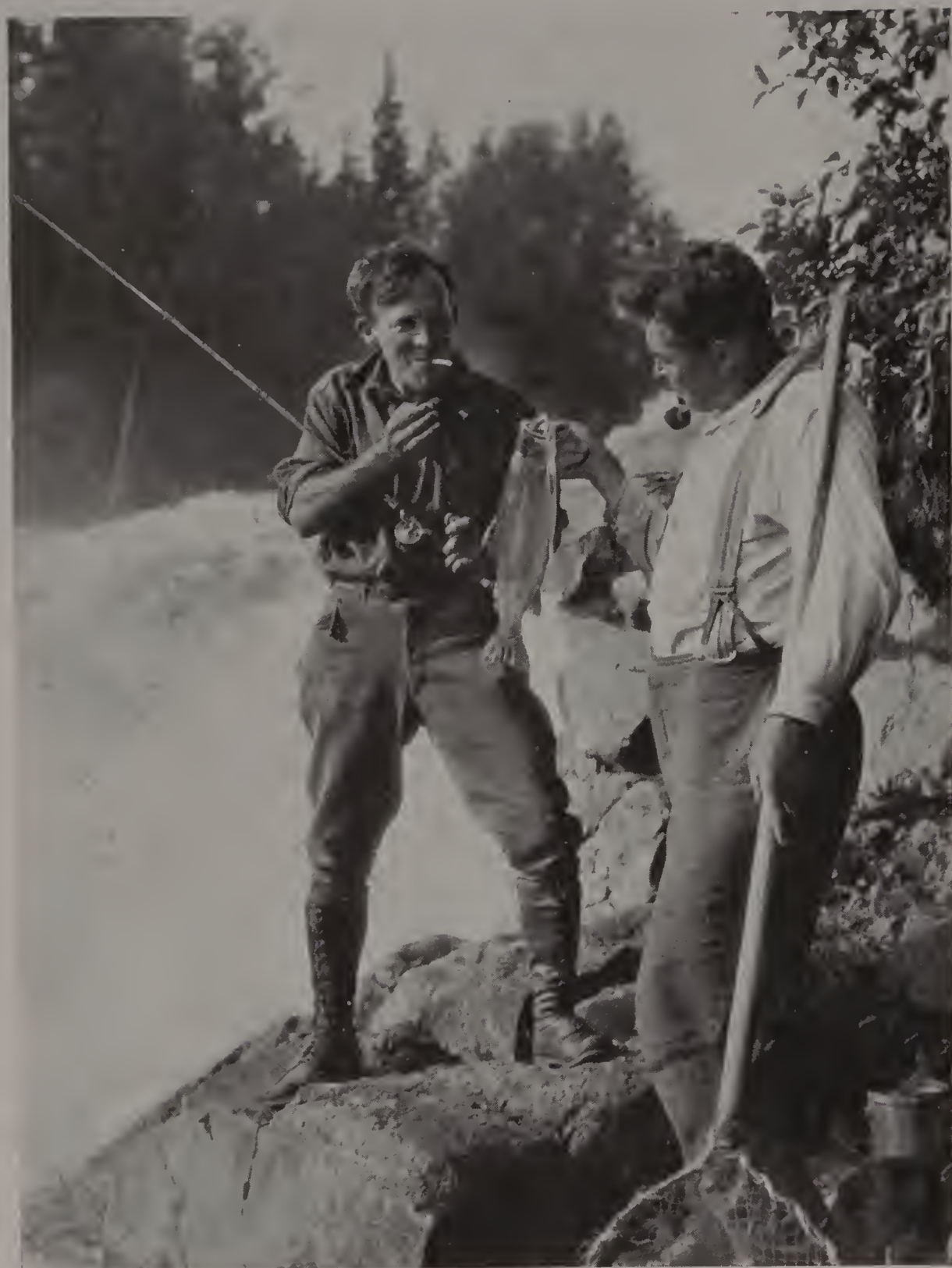
All fishes are not equally susceptible to these temporary mollusk parasites; some receive very few, others shed them too soon, while still others die as a result of carrying too many. Practical work is in

progress, and large numbers of fishes "infected," as it is called, with young Mussels are liberated to stock the public waters, as their "parasites" develop and fall off.

TURTLES, FROGS, AND CRAYFISH

The "planting" of the Mussels is, therefore, left to the fishes. It is even possible to send Mussel-bearing fishes to waters outside the Mississippi system and thus introduce the more valuable Mussels elsewhere.

There are several species of large Turtles of the kinds known as "sliders" in



Photograph by H. Armstrong Roberts

THREE-POUND SPECKLED BEAUTY, NIPIGON RIVER, CANADA

our fresh-water streams and lakes, especially in the Middle and Southern States, that contribute to the food supply. They have long been used in filling the ever-widening vacancy in the markets formerly occupied by that favorite of the epicure, the Diamond-backed Terrapin of the salt-water marshes.

They have so high an edible value that it is whispered we often pay Terrapin prices for Turtles that never saw brackish water. Fishery officials are aware of their importance and have studied their distribution, methods of capture, and conservation.

Frogs of several kinds are valued aquatic food delicacies, and their habits have received considerable attention with the view to developing a practical system

of frog-culture. It is to be hoped that some method of conservation will be found before the natural supply approaches the point of exhaustion.

The annual market supply of fresh-water Turtles and Frogs has been known to exceed half a million pounds of each, the great bulk of the catch being derived from the Mississippi and its tributaries.

The humble Crayfish, although of small size, figures prominently in the aquatic food supply, Lake Michigan leading with over 200,000 pounds annually.

FOODS OF FISHES

A subject of perpetual interest to all who fish with the rod is the food of fishes. There are moments in the lives of all of us when the most important thing in the world seems to be how to get the fish to bite. The problem is taken as seriously by the

captain of some great industry, off on a fishing trip, supplied with the most expensive tackle, as by the barefooted urchin with a homemade pole, and doubtless the man of business is the more serious of the two.

Thanks to the patient laboratory investigations of Professor S. A. Forbes, this dark question has been made luminous. He tells us that while the food of fishes consists chiefly of other fishes, it includes practically the whole aquatic fauna—a comforting fact when we would seek for baits.

Fishes not only feed on other fishes and on insects, but on crustaceans, mollusks, and worms. Plants do not constitute much of their food, although a few kinds feed on them, such as Buffalo-fishes,



Photograph by A. W. Cutler

FISH THAT EAT OUT OF A FRIENDLY HAND

In a pool on the estate of Kenneth McDougall, Port Logan, Scotland, the fish, mostly Cod, will take food from the keeper's hand.

Carps, and Minnows. Some fishes get food by rooting in mud, while others are inclined to be scavengers.

Among the chiefly fish-eating fishes may be mentioned Pike, Pickerel, Muskellunge, Pike-perch, Burbot, Gar, Black Bass, and Channel Catfishes. Those taking fish food in moderate amounts are represented by Bream, Blue-cheeked Sunfish, Mudfish, White Bass, Rock Bass, and Crappie.

Fishes which feed on other fishes to a trivial extent are White Perch, Suckers, Spoonbill, the various Darters, Top Minnows and Silversides, Sticklebacks, Mud Minnows, Stone-cats, and common Minnows. The whole Minnow tribe contributes to the food of the smaller fish-eaters.

In the Mississippi region the Gizzard-shad constitutes 40 per cent of the food of the Wall-eyed Pike, 30 per cent that of the Black Bass, half that of the Pike, and a third that of the Gars. This is a good illustration of the usefulness of an abundant species of little importance as food for man.

Mollusks—the Snails and Mussels of various species—are also important as

fish food. They form large proportions of the food of Catfishes, Suckers, Freshwater Drum, and Mudfish. About 16 per cent of the food of Perches, Sunfishes, Top Minnows, and Shiners is molluscan in character.

Fishes feed freely on insects, not only on the aquatic forms in their various larval and mature stages, but also on terrestrial insects cast into the water in many ways.

Crustaceans appear to be of even more importance as fish food, especially the minute Entomostraca. The Crayfishes are also eaten.

The food of adult fishes naturally differs greatly from that of the young. In addition to natural foods, both alive and dead, fishes in captivity will devour many kinds of meats and prepared foods. The question, then, as to what constitutes the food of fishes may be answered: almost any living animal forms from the water not too large to be swallowed. Therefore if the fish will not take the bait or the fly first offered, it may be tempted with another, and the resourceful angler need not return with an empty creel.



Photograph by Clifton Adams

THE GREAT LAKES ARE RESERVOIRS OF FISH FOOD

A Lake Michigan power fishing boat just in from the morning's work with the nets, Charlevoix, Michigan. Lake trout fill its crates. The trout are sent to local packing plants, frozen in ice shavings and then placed in cold storage until sold. Mid-west cities out of reach of the seaboard are familiar with the fresh fish of the Great Lakes.

Little can be learned definitely about the ages attained by fishes, unless individuals are kept under observation in captivity.

AGE, GROWTH, AND HABITS OF FISHES

The records of public and private aquariums, however, furnish data that we may consider reliable. The European Eel has undoubtedly lived for long periods in captivity. According to accepted authorities, a few specimens kept in aquariums have lived for periods varying from 20 to 55 years. Boulenger, in the Cambridge Natural History, states that an Eel kept by the French naturalist Desmarest for "upwards of 40 years" reached a length of four and a half feet.

It is recorded that four Russian Sterlets had lived in the private aquarium of Captain Vipan in Northamptonshire for 25 years. He also had a Golden Orfe still living after 24 years of captivity. A record from the Brighton Aquarium is that of a Sterlet which died after having been kept there "about 38 years."

The Australian Lung-fish is known to have lived at the London Zoölogical Gardens more than 19 years.

There are accounts of European Trout said to have been kept in captivity for 53 years, and of Carp still longer, but such are hardly comparable in verity with the records of existing public and private aquariums.

The New York Aquarium still has specimens (1924) of the Mudfish or Bowfin and the Long-nosed Gar which were received in 1903. There are also living Short-nosed Gars brought from the Mississippi River in 1904.

In the Aquarium certain North American fishes have lived for long periods, viz., Striped Bass, 20 years; Whitefish hatched in the building in 1913 are still living; Large-mouth Black Bass, 11 years; Muskellunge, Calico Bass, Rock Bass, and Yellow Perch, 10 years. The last four were adults when received and are still living.

A Striped Bass kept in captivity for 19 years weighed 20 pounds and was three



GOVERNMENT MESSENGERS PLANTING FISH

Before transferring fish from cans to an open stream, it is necessary gradually to bring the water in the cans to the approximate temperature of that in the stream; otherwise the fish will experience a shock.

feet long when it died. Its length when received was about six inches. This species sometimes attains a weight of 80 pounds or more. It is likely that some species grow faster in freedom, where they find their natural foods, but other kinds may develop faster in suitable ponds, where they are well cared for and protected from enemies.

TELLING THE AGE OF A FISH BY ITS SCALES

Wild fishes of exceptionally large size being often found, we may assume that fishes continue to grow through life, the period of life depending largely upon enemies. In a world beset with sharp fangs and claws, the life of a wild animal, either in the water or on land, is apt to end in a tragedy.

It is now known that the scales of fishes

bear marks which indicate the length of life and the rate of growth in different years. Studies of the Atlantic Salmon in Scotland and of the various species of Pacific Salmon have proved this.

The scale grows in proportion with the rest of the fish, principally by additions around its border. The fish grows at different rates during different seasons of the year. Concentric ridges form around the edge of the scale, its marginal expansion in summer being more rapid than in winter, so that the growth during each year is usually distinguishable. (See illustration, page 80.)

Studies of the five species of Pacific Salmons have shown the ages at which the different species return to the rivers to spawn. Thus, the ridges on a fish's scales are comparable to the annual ring



Photograph by Leonard Sefing

BRAVING THE UNNATURAL ELEMENT

A Black Bass leaping out of the water for food. This amazing photograph of a favorite game fish of American lakes and streams, taken with a speed camera, is a product of much patience and good eye-sight.

growths revealed on a cross-section of a tree trunk, which tell its age.

Studies of the scales of Whitefishes in the Great Lakes have shown that the scale characters are so well defined that they indicate the age of the individual fish and the rate of growth of the species.

Scales from Whitefishes hatched and reared in the New York Aquarium and therefore of known age have been used by Government biologists in checking the results of studies of the scales of wild fishes.

The sexes of fishes are not as readily distinguishable as in the case of birds. Males and females are usually so much alike that only the expert recognizes the differences, and in many species the dissecting knife must be employed to determine the sex.

The colors of fishes vary somewhat according to the waters which they inhabit, and this applies also to fishes held in captivity, where their colors tend to become more subdued. The fishes of exhibition tanks, however, brighten their colors during the spawning seasons, much as do wild fishes.

The habits of fishes have not been studied as thoroughly as have those of birds, mammals, and other vertebrated animals. Books on fishes are largely of two classes: those written by anglers, relating chiefly to methods employed in the capture of the fish, and those written by the systematic naturalist, dealing chiefly with classification and distribution.

A BIG FIELD FOR SCIENCE

In neither class of books is the life of the fish in its own environment very fully considered. There are, of course, satisfactory life histories of certain common species, especially those inhabiting the smaller streams, and fish-culturists are contributing new information on the ways of fishes reared in ponds.

Since the keeping of fishes in aquariums became common, many important facts have been recorded, but observations on creatures in captivity can manifestly deal with but little of their real life.

For many important facts relating to the senses of fishes we are indebted to the modern biological laboratory. Facts based on scientific experiment relative to fishes' powers of hearing and memory, their color changes, sleep, electrical and poison-

ous properties, the sounds they make, and so on, are slowly being made apparent.

The naturalist who can devote himself to the observation of the ways of fishes will find a fascinating field and contribute new facts to science.

SPOTTED CATFISH (*Ictalurus punctatus*),
COMMON BULLHEAD (*Ameiurus nebulosus*) and other Catfishes

(For illustration see Color Plate, page 111)

There are many kinds of Catfishes in the United States, all of which belong naturally to that part of the country lying to the east of the Rocky Mountains, those now abundant in some States west of the Rockies having been introduced.

Catfishes are of considerable importance commercially. The fishery statistics of a few years ago show that the annual catch for market exceeded 14,000,000 pounds, but to-day the supply is much smaller.

Since they are easy to catch, the total of those taken everywhere with hook and line can only be conjectured, but it may possibly equal the quantity yielded by the net fisheries.

As Catfishes in general have the habit of guarding their nests and protecting the young, the supply holds out well in spite of exhaustive fishing. Such habits also as feeding chiefly at night and feeding but little in winter contribute to their preservation.

The Blue Catfish, inhabiting the Mississippi Valley, is the largest and best of all as a food-fish. It occasionally attains a weight of 125 pounds and 80-pound specimens are not uncommon, but like other fishes taken in large numbers, the average weight is only a few pounds.

The Blue Catfish is less inclined to live in muddy waters than some other species, preferring the clearer and swifter streams. It is a clean feeder, living much on fishes and Crayfish. As a game fish it is one of the best in the Catfish family, taking many kinds of baits, and is a strong fighter on the line, but never adds to the angler's thrill by leaping from the water.

The Blue Catfish is decidedly given to migratory movements according to seasonal changes in temperature, gathering in the more southerly parts of its range in winter.

The Spotted Catfish (*Ictalurus punctatus*) belongs in the Mississippi Valley and the Great Lakes. It does not reach the size of the Blue Cat, seldom weighing as much as 25 pounds. Like the Blue Catfish, it is a trim and active fish. There are four species in this genus, all having forked tails.

One of the best-known Catfishes is the Common Bullhead (*Ameiurus nebulosus*) inhabiting streams, lakes, and ponds of the Eastern and Middle States and distributed as far westward as the Dakotas and Texas. Another fish of this round-tailed genus is the Black Bullhead (*Ameiurus melas*), having much the same distribution. The Bullheads are easily raised in ponds, and under proper management yield a good supply of white and palatable fish food. All of our native Catfishes have tough, scaleless skins and small eyes, and all have eight barbels or feelers on upper and under sides of the mouth, which are useful in searching for food in the muddy waters that many of them inhabit.

Catfishes make their nests usually in sheltered



RESCUING FISH FROM A MISSISSIPPI RIVER SWAMP

On June 1, 1915, this bayou covered 11 acres, and on November 15, 1915, it had wasted away to a pool 35 feet by 50 feet and 14 inches deep in the deepest part. Some of the fishes had been seined out earlier in the season, but on the final clean-up 150,000 were rescued and removed to open water. They comprised more than ten species of food and game fishes, including 30,000 Catfish, 15,000 Crappie, 25,000 Sunfish, and 15,000 Buffalo-fish.

spots, such as can be found under rocks, submerged logs, and stumps, and do considerable excavating in enlarging them. They are spring-time spawners. The eggs hatch in a few days and the young stay with the parent fish until about an inch long.

Catfishes in general are omnivorous, feeding on animal life, and are not averse to downright scavenging. They are very hardy and few fishes can live longer out of water. As they have dangerous spines on dorsal and pectoral fins, fishermen soon learn to handle them circumspectly.

As kept in tanks, Catfishes become nearly dormant when the water turns cold. A 60-pound Mississippi Catfish (*Leptops olivaris*), which lived in captivity several years, took no food during the winter months and remained practically motionless.

The name Channel Catfish is a term rather loosely applied by fishermen to several of the larger fishes of large streams.

Fully a dozen of our numerous kinds of Catfishes are important as food.

THE BLACK BASSES (*Micropterus dolomieu* and *Micropterus salmoides*)

(For illustration see Color Plate, page 112)

The two closely related Black Basses are easily distinguished by the size of the mouth and by the color pattern. In the Small-mouth species the upper jaw does not extend beyond the eye, as in the case of the Large-mouth Bass; in the former there is much dark blotching, which tends to form short vertical cross-bands, while the latter has usually a dark band along the side.

The expert angler thinks he can distinguish the species he has hooked before seeing it, as the Small-mouth Black Bass is by far the gamier and more active. Its reputation as a game fish is not surpassed by any other of its size.

Although the Black Basses are cultivated and distributed, both officially and by private effort, they are not fishes whose mature eggs can be stripped by hand and developed in hatchery buildings by wholesale methods. Their propagation is effected by the more natural but slower method of pond culture, in which the fishes are provided with the conditions most favorable to their mating and the rearing of their young.

The same limitations in culture apply to all fishes of the Bass-Sunfish family, which have the habit of making nests and protecting their young.

The Small-mouth Bass is the fish that pond-owners find most satisfactory and they are justified in the selection. Much of its present wide distribution is due to this fact.

This truly American fish has been much written about and naturally has many names in its extensive range, but Small-mouth Black Bass is the most widely used as well as the most distinctive. It is found from Lake Champlain, through the Great Lakes to Manitoba, along the Atlantic slope to South Carolina, throughout the upper Mississippi Valley, and in the lakes of southern Canada.

The size of the Small-mouth Bass depends largely on the waters it inhabits. Fishes of four or five pounds are decidedly large. There are records of specimens still larger, but the angler of to-day in our overfished streams and lakes is well content with a two-pounder.

The Black Basses defend their eggs on the spawning nests with great vigor and it is the male

that assumes this task, the female deserting as soon as the eggs have been deposited. His care is continued for a few days after the young appear, when they begin to scatter.

The Large-mouth Black Bass has a wider distribution than the Small-mouth species, especially southward, extending into Florida and other States along the Gulf coast. It is in general more abundant and inhabits more sluggish waters.

In the North the two species are commonly found together. The Large-mouth species is decidedly larger and in Southern waters sometimes exceeds 12 pounds in weight, but average weights are two or three pounds.

This fish has even more names than its relative, but Large-mouth Bass serves to identify it wherever the two are found together. As a popular game fish, we are safe in placing it next to the Small-mouth Bass.

The Black Basses are carnivorous fishes, the young feeding largely on insect life, the adults on fishes, Crayfish, and Frogs. In bait fishing these foods, together with the larger insects and their larvæ, are all used. Expert anglers take both species successfully with trolling spoon and artificial fly.

ROCK BASS (*Ambloplites rupestris*)

(For illustration see Color Plate, page 113)

Among the native fresh-water fishes living in the Aquarium there are few that adapt themselves more readily to the conditions of captivity than the Rock Bass. In a tank now containing fifteen specimens, mostly of large size, there have been no losses for several years.

The natural range of this fish includes the Mississippi Valley, the Great Lakes, and Lake Champlain drainages, but it has been introduced through fish-cultural operations into many States east of the Alleghenies. Its adaptability to pond cultivation will ultimately extend its distribution.

The methods of the expert angler are not at all necessary for the capture of the Rock Bass. Great numbers are taken by amateur fishers wherever it abounds and during the greater part of the year.

In its feeding habits the Rock Bass is about as omnivorous as any member of the Bass-Sunfish family, to which it belongs. Crayfishes and other fresh-water crustaceans, aquatic insects and their larvæ, Snails, and such fishes as its rather large mouth will admit, all contribute to its natural food supply. If we include the grasshoppers, crickets, grubs, earthworms, and other terrestrial baits used in catching it, the food list might be considerably extended. Fish-culturists have found that this species not infrequently cannibalizes to some extent on its own young.

In addition to the baits already mentioned, the trolling spoon and other artificial lures are used successfully; but the Rock Bass has few of the fighting qualities of the Black Basses, for it soon yields to the pull of the line.

The Rock Bass is a thick-bodied, meaty fish, and a couple of fair-sized ones will fill the pan. There are specimens in the Aquarium a foot long that have nearly trebled in size since their arrival, six years ago. It is known, however, to grow somewhat larger.

At spawning time, late in May, the Rock Bass makes its nest in shallow water along shore, like Basses and Sunfishes generally. The fishes are sociable at this time and their nests are often found



Photograph by W. M. A. Cowan

IN THE MATTER OF NUMBERS PERCH ARE THE HERRING OF FRESH WATER

A string of perch from Schroon River, Chestertown, New York. The Yellow Perch comes near to being everybody's fish. But little art is necessary to taking it. The Yellow Perch is ready to sample all baits of the amateur and even responds to bait let down through the ice in winter.

in groups close together, which is not the habit with the pugnacious male Black Basses.

CALICO BASS (*Pomoxis sparoides*) and
CRAPPIE (*Pomoxis annularis*)

(For illustration see Color Plate, page 114)

The Calico Bass belongs naturally to the region including the Great Lakes and the Mississippi Valley. Being a good food-fish and well adapted to cultivation in ponds, its distribution has been considerably extended by artificial means.

Like other widely distributed fishes, it has several names, one of which, Black Crappie, is sometimes used to distinguish it from its nearest relative, the Crappie or White Crappie. Both kinds are found in the above-named region, but, being of similar appearance, anglers do not always recognize the differences.

The Calico Bass has a relatively deeper body, is darker than the Crappie, and weighs more as compared with a Crappie of the same length. Naturalists easily distinguish them by their dorsal spines, the Calico Bass having seven or eight, while the Crappie has five or six.

The name Calico Bass is suggested by its markings, the Crappie being always paler. Both kinds are found in Western markets. The annual market catch in the Mississippi Valley, of the two combined, sometimes exceeds 1,000,000 pounds. The Calico Bass is chiefly a feeder on aquatic insects and their larvæ. It lives peaceably with other fishes when kept in ponds. So many are taken by

anglers that it has been called "the fish for the millions."

If the Calico Basses which have lived in the Aquarium for 10 years continue to thrive in captivity it will be interesting to see what size they attain with increasing age. Exceptionally large specimens have been reported as exceeding two pounds in weight.

WHITE PERCH (*Morone americana*)

(For illustration see Color Plate, page 115)

There are few native fishes that live equally well in fresh or salt waters. The White Perch, living chiefly in brackish tidal waters, ranges freely into both. In rivers it passes up beyond all trace of salinity and often becomes land-locked in strictly fresh ponds, where it breeds for considerable periods. On the other hand, it is taken in abundance about coastal islands where conditions are altogether those of the salt sea.

In aquariums it has been kept for long periods in tanks, either fresh or salt, but the best results have been obtained in tanks supplied with both kinds of water. There are specimens now living in such artificially maintained brackish water that are 10 years old. They have reached lengths of 10 to 12 inches and continue to be hardy under the restrictions and the monotonous fare of life in captivity.

Years ago specimens of live White Perch intended for exhibition were obtained from one of the park lakes in New York City where they had

been introduced; but, although fully protected, the supply gradually diminished to the vanishing point. It would seem, therefore, that the race cannot breed indefinitely in fresh waters, but must renew its fertility through occasional baths in the vitalizing sea.

Complete exclusion from the brackish or fresh waters, where it spawns, would doubtless lead to extermination as readily as long-continued imprisonment in absolutely fresh water. According to the records of anglers, the largest specimens are those taken in salt or brackish waters.

The White Perch belongs to the tidal region of the Atlantic coast from Nova Scotia to South Carolina. It is abundant around Long Island and in the Hudson River up as far as Albany. It is taken through the ice in the Hudson, where it is present throughout the year.

It is equally abundant in the Delaware and Susquehanna rivers and Chesapeake Bay, ranging well upstream, and is commonly taken in pound and fyke nets along the coast.

In North Carolina the annual catch amounts to 1,000,000 pounds. Anglers catch it in abundance and net fishermen keep the markets well supplied with it. Fishery statistics show that the market catch along the Middle Atlantic States sometimes amounts to 2,000,000 pounds a year.

The White Perch is good eating, either from fresh or salt water. Hook-and-line fishers find Shrimp bait the best, but it responds readily to Minnows, young Eels, small Crabs, or any of its natural foods. Specimens of two or three pounds are reported from the eastern end of Long Island. In fresh waters, worms, grasshoppers, and other insects are effectively used.

The White Perch rises to the fly, especially in fresh waters, and resists bravely when hooked. A fish a foot long weighs about two pounds, but this is larger than the average.

It is a gregarious species, usually frequenting the shallower waters along shore. Spawning begins soon after the ice leaves and lasts a couple of months. Females have been taken with eggs as late as June 10. Fish-cultural experiments have shown that the eggs can be hatched artificially in from three to five days.

Considering the adaptability of the White Perch to the conditions of captivity, especially in brackish



Photograph by S. N. Leek

A NATIVE SON AND NATIVE TROUT: WYOMING

The Trout shown here are doubtless one of the numerous species of the Rocky Mountain region, known as Black-spotted or "Cutthroat"—probably the Yellowstone Trout (*Salmo lewisi*) inhabiting the Snake River basin above Shoshone Falls.

water, there is reason to suppose that it will receive more attention from fish-culturists than it has in the past. Anglers would know it better if its range extended farther inland.

BROOK TROUT (*Salvelinus fontinalis*)

(For illustration see Color Plate, page 116)

The Brook Trout is the favorite game fish of America. Originally found from Labrador westward to the Saskatchewan and southward along the Alleghenies to Georgia, it has been carried by fish-culturists to the Rockies, the Sierras, the upper Mississippi Valley, and wherever rapid streams of suitable temperature are found.

It has almost disappeared from lowland streams in the North, which have become unsuited to it as a result of deforestation and water pollution.



Photograph by E. R. Sanborn, New York Zoölogical Society

BROOK TROUT, BEST BELOVED OF MANY LIGHT-ROD FLY-FISHERMEN

This fish thrives in cold torrents which grosser fishes do not enter. No part of our outdoor heritage is more worthy of conservation than the rapid Trout waters of the mountains.

The Brook Trout persists in small coastal streams where the conditions favorable to it have not been disturbed, and it often descends to brackish water. It will live in streams having a summer temperature as high as 70 degrees, provided they have swift currents.

The Brook Trout cannot live through the summer in the New York Aquarium without the aid of refrigerated water, although the city supply is derived in part from the Catskill Mountains and flows 100 miles underground. The Brook Trout will live in cool lakes and ponds, but cannot reproduce in such situations without access to the gravelly beds of running brooks at spawning time.

Trout culture in America dates back to the early fifties. Fish-culturists raise great numbers of Brook Trout, both for market and for distribution in small artificial ponds, by feeding the fishes and caring for the eggs in hatchery troughs provided with flowing spring water.

The instinct to move upstream is very strong in young Trout; when a miniature "fishway" with its stairs of tiny box pools is connected with a hatching trough, they will promptly begin to ascend and cannot, in fact, be kept down while water is allowed to flow through it.

The Brook Trout spawns in the fall, when streams begin to cool, but the eggs do not hatch out until springtime brings higher temperature. The hatching period lasts from three to six months, according to latitude and altitude. The Brook Trout spawns when two years old. Larger and older fishes deposit from 500 to 2,000 eggs.

In lakes where there is an abundant food supply, the Brook Trout has in the past been known to reach the rare weight of 10 pounds; but to-day, when thousands of anglers are whipping the Trout streams, a one-pound Trout is a large one. Many good Trout waters have been ruined by the ill-advised introduction of predatory fishes.

The coloration of the Brook Trout is extremely variable. In some waters the fish may exhibit all the brilliancy of which it is capable, while in another watershed not far away it is so dark that but little color is discernible.

A notable illustration of this is found on Long Island, the Trout on the south side of the island being among the showiest of the species, while those of the north side are as dark as the Brook Trout ever becomes, although the supply on both sides is maintained by hatchery-raised fishes. After a few months in captivity, the bright colors of the former tend to disappear, while the latter become somewhat paler. This may be due largely to a change in diet and the exclusion of direct sunlight from the tanks.

In the Trout, as in many other fishes, the colors vary with age.

In streams the Brook Trout is largely a feeder on aquatic insects, while in lakes and ponds it feeds much on small fishes. In the Aquarium it subsists cheerfully on chopped fish, like the other captives of the tank, and in the average hatchery pond becomes a fat liver-fed gourmand.

The Brook Trout is not a leaping fish, like the Bass, when hooked, although it may rise clear of the surface in striking the fly.

We need not describe methods of capturing the Trout; anglers have been writing of this in great detail since the days of the Father of Anglers. No native game fish is more worthy of protection in the waters still suited to it than the Brook Trout.

LAKE TROUT (*Cristivomer namaycush*)

(For illustration see Color Plate, page 117)

The Lake Trout of the Great Lakes belongs chiefly to the fish trade. In these inland seas the angler's share is small in comparison. It is the largest of all Trouts and is known to have reached a weight of 100 pounds. The average of those taken in the gill nets used at the present time weighs less than 10 pounds, while those caught by anglers along shore average but half that weight. The writer once accompanied a northern Alaska expedition, a member of which brought into camp specimens of this Trout exceeding three and a half feet in length. They were taken in a large lake at the headwaters of the Kowak River, above the Arctic Circle, where they were very abundant.

Among our fresh-water fishes the Lake Trout ranks next to the Whitefish in commercial importance. It is found throughout the Great Lakes and from there northward, in all the large lakes of British America and Alaska.

A deep-water form of this Trout, called Siscowet, is taken in great numbers in Lake Superior, the gill nets being set at times in depths exceeding 500 feet and lifted by steam power. The writer once made a cruise north of the Apostle Islands on a steam fishing boat operating 40 nets, each 600 feet long. These were set in one "gang," constituting a single net more than four miles in length.

Each deep-water fishing boat attends to four or five of these great nets. As the net is lifted by the windlass forward, it is carried aft in sections, put together again, and paid out over the stern. The nets were about eight feet wide, with four and a half inch mesh.

The largest of the deep-water Lake Trout taken by our vessel was two feet ten inches long and weighed 21 pounds.

It would be interesting to know the greatest depth at which Lake Trout have been taken, as Lake Superior, one of the deepest lakes in the world, has depths exceeding 1,000 feet and its bottom is far below sea-level.

Some time later a day was spent on a steam fishing boat in the Georgian Bay near its connection with Lake Huron, and the lifting of a gill net six miles in length was observed. It was set at a depth of 100 feet and the work of lifting and resetting occupied five hours. The catch was nearly 1,000 pounds of Lake Trout, the largest of which was three feet long and weighed 15 pounds.

There are many steam vessels in the Great Lakes engaged in such wholesale fishing, as long as the Lakes are free from ice. The annual net catch of Lake Trout in the Great Lakes in 1917 exceeded 13,000,000 pounds.

The writer has taken Lake Trout in the Georgian Bay at depths of about 50 feet with hand line and trolling spoon, but the sport would have been better had rod and reel been used. Anglers who have used the rod with 300 feet of line and Minnow bait find that the fish can be played in a satisfactory manner.

Surface trolling, when the Trout are found in shallower waters, affords better sport. In smaller and shallower lakes, like those of Maine, where summer water temperatures are higher than in the Great Lakes, the Lake Trout is often taken with the fly. In Seneca Lake, in New York State, it is taken with a special trolling rig, designed to play the spoon 10 or 20 feet under the surface.

The Lake Trout is easily distinguished from other Trouts by the numerous small, pale-yellowish spots which cover its body from head to tail. It is a voracious fish. Forbes tells of a 20-pound Lake Trout which had 13 good-sized Lake Herring in its stomach.

Lake Trout fry are turned out by the fish hatcheries in great numbers. The spawning season varies in different lakes. Five or six thousand eggs are stripped from fishes of ordinary size, but large specimens yield many more. The eggs hatch in from two to three months.

The Lake Trout endures captivity very well; the Aquarium has 20-inch specimens received in 1919, some of them perfect albinos with bright pink eyes.

Several names are applied to the Lake Trout, one of which is Mackinaw Trout. In the lakes of Maine it is called Togue, while in Canadian lakes it goes by the Indian name Namaycush.

McCLOUD RIVER RAINBOW TROUT (*Salmo irideus shasta*)

(For illustration see Color Plate, page 118)

The Rainbow Trout belongs to the Pacific slope of the Sierras and Cascades; wherever it is found to the eastward of these ranges it is an importation.

There are several geographic races of this Trout, the one now found in Eastern streams and lakes being the northern California variety, *Salmo irideus shasta*. Commencing in the early eighties, the original stock was widely distributed from the Government hatchery on McCloud River south of Mount Shasta. It was the writer's good fortune to be attached to this station years ago and to participate in its work.

The acclimatization of this fish in other parts of the United States and in foreign countries is one of the notable successes of modern fish culture. Taken to New Zealand in the late eighties, it soon became well established there.

The introduction of the Rainbow Trout in Eastern States provided a substitute for the Brook Trout in many waters which had become unsuitable for that species, as a result of advancing civilization.

While generally not as large in the East as in its native Sierra streams, it has in certain favorable localities been found even larger. It can endure warmer water than the Brook Trout and live farther downstream than that species. In streams near the sea it often lingers in brackish water.

While the Rainbow Trout is a springtime spawner on the Pacific slope, depositing its eggs from February to May, it has in its Eastern habitat adapted itself to the very different climatic conditions prevailing there and now spawns in the fall and early winter, like the Brook Trout, but the eggs hatch in less time.

The vitality of the artificially fertilized eggs has made it possible to ship them to great distances in a half-incubated condition, after which the hatching process can be completed by ordinary fish-hatchery methods. In this way fertilized eggs of the Rainbow Trout have been sent to the Atlantic coast, to Europe, and even to New Zealand in refrigerated packages with but little loss.

This is the method now used in distributing not only Trouts and Salmons, but many other kinds of fishes.

Eastern anglers do not usually rate the Rainbow with the Brook Trout as a game fish, but we can-

not believe that this criticism applies in its native rivers. It is, perhaps, true that it is there a better food fish. Anglers have their own ideas on such matters, and are not to be dissuaded from opinions formed in places where they have enjoyed good sport.

In the McCloud River we have taken three- and four-pound specimens, but the average is smaller. It is known to attain a weight of 10 pounds, especially when transplanted to warmer waters, or where the food supply and the large area of a lake provide conditions favoring greater growth.

It is probably not so gamy a fish in warm waters as in mountain streams. We have seen it leap repeatedly when hooked—a thing the Brook Trout seldom does.

The Rainbow is a fine sportsman's fish, taking the fly much like other Trouts, and is not a competitor of the Brook Trout in maintaining a place in the wider habitat now afforded it.

In some localities the identity of the Rainbow is confused with that of the Steelhead (*Salmo gairdneri*), also a Pacific coast fish, which has been successfully acclimatized in streams flowing into Lake Superior, Lake Michigan, and elsewhere. It has smaller scales than the Steelhead. In California the Rainbow is not inclined to seek the sea like the Steelhead, while the latter ranges far inland at spawning time, like the Salmon. A few Steelheads have been taken in the McCloud River 300 miles from salt water, and it is not unlikely that some of the Steelhead eggs were unwittingly shipped from there with eggs of the Rainbow.

With its broad, iridescent, purplish-red band along the side, the Rainbow Trout is well named.

EASTERN PICKEREL (*Esox reticulatus*)

(For illustration see Color Plate, page 119)

The Eastern Pickerel—the largest of our three species—belongs chiefly to the region east of the Alleghenies, from Maine to Florida. It reaches a length of two feet and a weight of seven or eight pounds. Two or three pounds would be near the average size, which varies, however, with the locality.

Chain Pickerel is a name much used in the North, while Jack is more common in the South. It is often confused with the Pike in waters where both are found.

Like others of the family, it leads a solitary life, except at spawning time. Pickerels captured by bait trolling in New Jersey lakes have been taken in rather shallow places, where they found shelter among water plants. Here also the Pickerel deposits its spawn. The eggs are thrown off in long masses like those of Perch and are usually seen among submerged brush and weeds. In the North it spawns in April and May; in the South it spawns earlier and grows faster.

The Pickerel stays in deeper water in winter and is then taken through holes cut in the ice.

It is said that in ponds devoted to fish culture a Pickerel five years old may be a foot and a half long and weigh two pounds, but rapidity of growth depends upon the abundance of food.

The Pickerel will seize a fish half as large as itself and swallow it by degrees.

All fishes of the Pike-Pickerel family are taken by similar methods. Fishes and Frogs are good live baits and are used in trolling, casting, and skittering and artificial lures are used in the same ways.



Photograph by E. R. Sanborn, New York Zoological Society

THE AMATEUR FISHERMAN'S DELIGHT: ROCK BASS

Whatever it may lack in reputation among scientific fishers, this species is one of the most popular among average anglers. From the St. Lawrence to Texas, the legion of the unskilled easily transfer it from its rocky haunts to the frying-pan.

"Skittering" is an angler's term; it is done with a long rod and a short line, by jerking the bait along the surface.

The Eastern Pickerel is probably a better game fish than either of the other Pickerels. These fishes, being rather easily caught, both in summer and winter, soon become reduced in numbers in the smaller water areas:

Another species, the Banded Pickerel (*Esox americanus*), also limited to the region east of the Alleghenies, is smaller than the Eastern Pickerel, seldom exceeding a foot in length. It inhabits chiefly lowland streams and swamps, often descending streams to brackish water.

The Little Pickerel (*Esox vermiculatus*) has a shorter body and longer head than its relatives. It is a fish of quiet waters and does not exceed a foot in length. It belongs to the Ohio and Mississippi Valleys and to streams flowing into the Great Lakes.

PIKE (*Esox lucius*)

(For illustration see Color Plate, page 119)

The Pike reaches but half the size attained by the Muskellunge. It has much the same distribution but a greater range northward. The writer has taken it above the Arctic Circle in Alaska.

The American Pike is probably not distinct from the Pike of the Old World, but the latter is believed to be larger. Being more widely distributed and abundant than the Muskellunge, it is better known to anglers and is of more economic importance.

The Pike, like the others of its family, is one

of the notoriously voracious fishes, destroying great numbers of other fishes and many water birds and small aquatic mammals. It is well equipped for the predatory life and is believed to eat about a fifth of its own weight daily. There is no doubt about its being the enemy of all fishes inhabiting the shallower waters. Only a few Pike can find subsistence in ponds and lakes of limited extent.

It is not a suitable fish for propagation in waters adapted to other fishes that are less piscivorous, and its cultivation should be restricted to such localities as are best adapted to it alone, and where it may subsist on fishes of the least value as game or food.

The Pike reaches a length of four feet and a weight of 40 pounds or more. There are several much-quoted records to the effect that the Pike of Europe and Siberia have been known to exceed 100 pounds in weight. Natives of the Alaska Peninsula told me repeatedly that Pike of enormous size inhabit Lake Iliamna.

It may be that the Pike attains its greatest size in far northern waters. In northern Alaska we found it abundant in all parts of the Kowak and its tributaries, especially in quiet lagoons leading off from the river. There were many lurking in shallow water among overflowed mosses, where we continually startled them in walking along shore.

Having little time for angling, we took such Pike as were needed for food by shooting them as they lay in the shallows with hardly enough water to cover them. This was early in August



Photograph by E. R. Sanborn, New York Zoölogical Society

THE CALICO BASS DERIVES ITS NAME FROM ITS MARKINGS

This fish is neither large nor noted for gameness, but it is the object of a vast amount of angling over a considerable part of the country. Market fishers take large numbers in the Mississippi Valley.



Photograph by E. R. Sanborn, New York Zoölogical Society

THE BIG AND POWERFUL MUSKELLUNGE, MOST VORACIOUS OF FRESH-WATER FISHES

This fish lies half hidden, in wait for his victim. His habit of motionless poise makes him a good subject for the camera.



Photograph by E. R. Sanborn, New York Zoölogical Society

TEN-YEAR-OLD WHITEFISH

These specimens were hatched in the New York Aquarium. Being the only Whitefishes of known age available, scales from them are used by biologists in checking the results of studies of the ages of wild Whitefishes.

when the cold Arctic streams are about as warm as they ever get, and the Pikes were probably spawning. In our Northern States they spawn soon after the ice leaves, and the eggs hatch in about three weeks.

The annual yield of Pike and Pickerel in the net fisheries of the Great Lakes exceeds 2,000,000 pounds. The identity of the Pike is often lost in the name Pickerel, with which it is associated in much of its geographic range.

An inhabitant of the shallower waters in summer, the Pike in winter seeks greater depths, doubtless following its food supply, and is taken on baited hooks set through the ice. In summer it is a solitary still hunter, lurking about the edges of weedy or brushy places. It is taken with all sorts of live and artificial baits, in trolling, casting, and skittering.

Many anglers consider Pike and Pickerel fishing a high form of sport and value them also as food-fishes, but there are others who think differently. We have enjoyed them both on the line and in the pan.

LAKE STURGEON (*Acipenser rubicundus*)

(For illustration see Color Plate, page 120)

The Lake Sturgeon is the largest fish of the Great Lakes and, next to the Paddle-fish and the Giant Gar of the Mississippi River, our largest fresh-water fish. It never reaches the great size of the Sea Sturgeons ascending rivers of the Atlantic and Pacific coasts. Milner, who examined many in

the early seventies, saw none longer than six feet, but found reports around the Lakes of larger Sturgeons. In 1922 a Sturgeon was taken in Lake Huron which measured seven feet three inches and weighed 225 pounds.

The history of the Sturgeon is a story of wanton waste. In 1872 Milner reported a fishing firm at Sandusky, Ohio, engaged in preparing smoked Sturgeon and caviar, which used from 10,000 to 18,000 Sturgeons a year. Before this firm began to utilize them the local catch of Sturgeons, which were always present in the nets, was destroyed as useless. This was also the practice elsewhere on the Lakes.

When the value of the fish was finally recognized, its decimation proceeded so rapidly that it soon became scarce and has been so ever since.

The difficulties encountered in the propagation of the Sturgeon by artificial methods have so far been only partially overcome. The breeding sizes available for experimental fish-culture are now so limited that extermination is feared.

In 1880 the catch of Sturgeons in the Great Lakes exceeded 7,000,000 pounds. In 1917 it had fallen to less than 100,000. In the upper Mississippi River and its tributaries the catch has fallen in proportion.

The Sea Sturgeons have also decreased at a rapid rate and fish-culture has made little progress in propagating any of them.

When we consider that the caviar alone from a single large female Atlantic Sturgeon is worth nearly \$100, it is easy to realize what the passing of this fish means. Such is the rate at

which we are harvesting our wild crops.

The Lake Sturgeon inhabits also the large interior lakes of British America, but statistics on the yield from those waters are not at hand. The small Shovel-nose Sturgeon of the Mississippi River, belonging to a different genus, is of much less value commercially.

The Lake Sturgeon is inoffensive as far as other fishes are concerned, except as it may disturb their eggs, being strictly a bottom feeder and living on mollusks, crustaceans, worms, and more or less small plant life. Its mouth, devoid of teeth and placed on the under surface of the head, is sucker-like in form and can be protruded downward like those of Suckers. The heavy snout is used for stirring up the bottom.

Sturgeons have lived only two or three years in the Aquarium, but doubtless would live longer in captivity were it practicable to keep them in mud-bottomed pools and supplied with their natural foods. Unfortunately, aquatic animals confined under the conditions now practiced are compelled to subsist, especially in winter, on such foods as the markets afford.

The Sturgeons are fishes of ancient lineage, the species having been more numerous in former ages, when they were more heavily armored with bony scales than are those now existing. All Sturgeons are at once distinguishable by their five longitudinal rows of heavy, bony scales.

The Sturgeon is an active fish, often leaping clear out of the water. It lives chiefly in the shallower waters along shore, where it spawns in June.

MUSKELLUNGE (*Esox masquinongy*)

(For illustration see Color Plate, page 121)

There are so many ways of spelling the Indian name of this fish that we have adopted the one apparently most in use, only after an orthographical search which revealed 24 ways of spelling it. The Muskellunge is the largest of the Pike family, being known to exceed 80 pounds in weight, while 40-pound specimens are fairly common.

It is a northern fish, inhabiting mainly the Great Lakes, Lake Champlain, Lake Chautauqua, lakes of Canada, the St. Lawrence River, and the upper Mississippi and tributaries.

It is celebrated as a game fish, having both size and strength. Unless equipped with a rod suitable



Photograph by T. J. Golden

A LAKE CHAUTAUQUA MUSKELLUNGE

This specimen, which was 52½ inches long, with a girth of 24½ inches, weighed 42 pounds.

for a large specimen, the angler may have to play the fish an hour before landing it.

Live bait casting and spoon trolling are the usual ways of taking the Muskellunge.

As a fish-eater the Muskellunge rivals the Barracuda of salt water, making the same fierce rushes and having a similarly large mouth set with dangerous teeth. There is, in fact, a superficial resemblance between these two widely separated fishes.

With a long, narrow body, strong dorsal and anal fins placed far back on the body, and a powerful tail, the Muskellunge is well equipped for speed. It has the look of a three-propeller craft, but the power is reserved for sudden bursts of speed, as it is not given to ranging far from its customary lair. The Muskellunge, like other fishes of the Pike family, is solitary in habit, lurking in sheltered spots, whence it darts upon its prey.

As food-fishes, neither the Muskellunge nor the other Pikes are usually rated as high as the Trouts and Basses.



Photograph by E. R. Sanborn, New York Zoölogical Society

GAR, A SURVIVAL OF EARLY FISH FORMS

The cylindrical body, long bony snout, and certain reptilian characteristics point to the Gar being a surviving link with the ages. One species, the alligator gar, inhabiting our southern streams is said to reach a length of 20 feet.

The Muskellunge with which we are best acquainted is the species belonging to Lake Chautauqua and the upper Ohio River system—*Esox ohienensis*. This species has long been on exhibition in the Aquarium, where 30-pound specimens have lived four or five years at a time and would have lived longer but for accidents to the water supply. Although well fed, they have occasionally attacked their large tank mates, inflicting serious injuries. It is sometimes called Barred Muskellunge. Mr. G. A. Winchester states that the largest specimen taken in Lake Chautauqua weighed 49 pounds. Forty-pounders are taken every season, but seven pounds is about the average for that lake. A 42-pound specimen was taken in Lake Chautauqua which had a length of $52\frac{1}{2}$ inches (see page 105). In this lake it is taken in summer by spoon trolling. In the autumn live baits—Suckers, Shiners, and Creek Chubs—are used.

Live-bait fishing is more effective at night and attracts larger fish. Skittering with dead Minnows is fairly successful in summer and both casting and skittering can be done over weedy areas. A good day's catch would be five or six fish. The State hatchery at Lake Chautauqua, between 1896 and 1920, turned out more than 69,000,000 Muskellunge fry.

The spawning season begins about April 20 and lasts three weeks. The Muskellunge spawns from 100,000 to 300,000 eggs, which are deposited mostly where brush, dead limbs, and logs lie in the water.

Another species of Muskellunge (*Esox immaculatus*) inhabits lakes in northern Wisconsin and Minnesota.

The members of the Pike family are readily distinguished by the scales on cheeks and gill covers. In the Muskellunge the cheek and lower half of gill cover are without scales; in the Pike the cheek is entirely scaled, the lower half of the gill cover being without scales; in the Pickerels cheek and gill cover are both fully scaled.

COMMON WHITEFISH (*Coregonus clupeiformis*)

(For illustration see Color Plate, page 122)

One of the most abundant and important food-fishes of the North is the Common Whitefish, which inhabits the Great Lakes and some other large lakes of the United States and British America.

There are several species of the genus, mostly of restricted range, inhabiting lakes in the Northwest as far as Alaska, but the Common Whitefish and the Menominee Whitefish (*Coregonus quadrialateralis*), also abundant in the Great Lakes, far exceed the others in commercial value.

The Common Whitefish is in the main the species on which the "Whitefish" industry is based. The catch in 1919 exceeded 6,000,000 pounds, or about half the quantity taken in 1890, so heavy is the drain made upon this food resource. The Whitefish catch along the Canadian shores of the Lakes being equal to that of the United States, we may double the above figures.

The Whitefish fortunately responds readily to artificial methods of propagation, and there are



A PACK-TRAIN OF HORSES LADEN WITH CANS OF YOUNG TROUT FOR PLANTING
IN A COLORADO LAKE

several hatcheries along the Great Lakes devoted to its increase. It is doubtless the favorite food-fish derived from inland waters. Planked Whitefish is considered as great a delicacy in the Lake regions as planked Shad around the shores of the Chesapeake.

The largest part of the catch is made in Lake Michigan and the least part in Lake Ontario. The gill net is the principal apparatus used in capture, but many are taken in pound nets and seines. The Whitefish is seldom taken with the hook, and then only with worm or insect bait.

It inhabits chiefly the deeper parts of the Lakes, moving into shallower waters early in summer, in midsummer seeking again the cooler depths. In the fall months Whitefish again come inshore to spawn, some of them entering streams for that purpose, but the migratory movements vary somewhat in the different Lakes.

Recent investigations have shown that the Common Whitefish is late in maturing, probably not spawning until after five years of age. It deposits on the average about 35,000 eggs, which hatch in about five months.

The food of the Whitefish consists of small crustaceans, small mollusks, and insect larvæ, but chiefly of various kinds of Entomostraca. Whitefish hatched in the Aquarium were carried through the critical period of infancy on a diet consisting of the larvæ of mosquitoes.

These fishes, now ten years old, have lived and grown on a diet of chopped fresh meat. Had it

been possible to supply them with their natural live foods, their size would doubtless have been greater. These specimens are apparently the only Whitefishes ever brought to maturity in captivity.

Whitefish eggs and young Whitefish are devoured in great numbers by predatory fishes.

The largest Whitefishes seldom reach a weight of 20 pounds, and such are rare, the average as brought to market being only three or four pounds. Females are larger than males.

The Whitefishes as a group are considered the most important fresh-water fishes in the world, and there can be no doubt of the fact that they are undergoing progressive depletion.

FRESH-WATER DRUM (*Aplodinotus grunniens*)

(For illustration see Color Plate, page 123)

The Fresh-water Drum is a large fish belonging chiefly to the Great Lakes and the Mississippi Valley. It reaches a length of three or four feet and a weight of 40 or 50 pounds. It is a food-fish, wherever taken, and more popular in the South than in the North.

In 1899 the catch of Drum in the Mississippi and its tributaries exceeded 3,000,000 pounds; in the Great Lakes in 1917 the catch amounted to nearly as much.

The Drum is a bottom fish, living mostly in muddy waters, feeding on Snails, Mussels, and Crayfish, for which its heavy paved teeth are well



Photograph by Redner Photo Company

THE CATCH OF ONE ARKANSAS FISHERMAN—118 FISH TAKEN IN TWO NIGHTS AND ONE DAY

All the larger specimens shown here are Catfish. There is good fishing in the streams of Arkansas; they have contributed to the markets in a single year 500,000 pounds.

adapted, and it is not given to the eating of other fishes.

It is not a popular angler's fish, but is often taken with Crayfish bait, and the young are better eating than the adults. The net fisheries take the bulk of those marketed. In the North it is often called Sheepshead, while in Louisiana it is best known as Gaspergou.

The Fresh-water Drum makes drumming or grunting sounds not unlike those made by the Sea Drum, and this is the meaning of its specific name, *grunniens*.

The noises made by Drums, Croakers, and other sound-producing fishes are accomplished by muscles drawn across the air bladder, by the grinding of their blunt teeth, and in other ways, fishes having no real vocal organs.

The ivorylike ear bones, or otoliths, of this fish are popularly known as "lucky-stones," a fancy originating in a marking resembling the letter L.

The Fresh-water Drum has proved to be a hardy fish in the tanks of aquariums, where it gets little of its natural food.

YELLOW PERCH (*Perca flavescens*)

(For illustration see Color Plate, page 124)

The Yellow Perch is one of our best-known fresh-water fishes, being abundant throughout the Northern and Eastern States, especially in lakes and ponds. On the Atlantic slope it extends somewhat farther south than in the Mississippi Valley, where it is confined to States bordering on the Great Lakes.

In the North it extends from Nova Scotia and Quebec westward to Minnesota.

The market catch by nets in the Great Lakes sometimes exceeds 9,000,000 pounds a year, while anglers in towns along the Lakes take great numbers and find sport in doing so. The catch by anglers in smaller lakes and ponds everywhere is very large.

The Yellow Perch comes as near to being everybody's fish as any other and but little art is necessary in taking it. It is ready to sample all the baits of the amateur and even responds to baits let down through the ice in winter, when many other fishes are sluggish. The expert takes it both with artificial fly and trolling spoon.

As a food-fish, there is none of better flavor among the commoner kinds. It is easily identified by its broad cross-bands of black, as no other native fresh-water fish wears the same combination of black and gold.

Like other fishes of extended range, it has several names, viz., Yellow Perch, Ringed Perch, Raccoon Perch, Red Perch or Striped Perch, according to locality. Its length may be as much as 14 inches and its weight about three pounds, but such sizes are unusual.

The Yellow Perch is one of the easiest fishes to introduce into new waters. The eggs are extruded in zigzag-shaped bands, which, by the rapid absorption of water, became large masses, seen along the shores in shallow water. Employees of the Aquarium gather such masses in the ponds of Long Island in March and April. They are hatched indoors as a springtime fish-cultural exhibit, the young fry being placed in local streams and ponds.

The egg masses may be found at any time after the ice disappears, according to the latitude.

Yellow Perch have been kept 11 years in captivity on no other food than fish purchased in the markets, although its natural live foods include practically all the smaller forms of fresh-water life.

The Yellow Perch runs in schools and frequents moderate depths. It is a difficult fish to dress because the scales cling so tightly to the flesh.

PIKE-PERCH (*Stizostedion vitreum*) and

SAUGER (*Stizostedion canadense*)

(For illustration see Color Plate, page 125)

The Pike-perch, perhaps better known as Wall-eyed Pike, ranks next to the Whitefishes and the Lake Trout in quality and commercial importance among the fishes of the Great Lakes, where the market catch in 1917 amounted to 4,500,000 pounds.

While the average weight of this fish in the Great Lakes is less than 10 pounds, it occasionally reaches a weight of 25 pounds and a length of three feet. In other northern waters the average is less than five pounds. The young are usually known as Blue Pike.

Although the Pike-perch inhabits clear waters everywhere in its range, it is a fish of the lakes rather than the rivers. It is found from Lake Champlain westward to Minnesota, in the interior lakes of New York, and in the Mississippi Valley, but through fish-culture operations its habitat has been greatly extended. Its range also extends well into British America.

Perhaps no fish lends itself better to artificial propagation; more than 300,000,000 were liberated from Federal hatcheries on the Great Lakes in 1921. A few millions are hatched annually in the Aquarium, where the process of incubation in glass jars always attracts the attention of visitors. As handled in the fish hatcheries, a large specimen may yield 300,000 eggs.

The Pike-perch belongs to the family of Perches, although its form is suggestive of the Pikes.

While it is regarded in the markets as one of the best of our food-fishes and great numbers are taken in the net fisheries, it is highly appreciated as a game fish. The angler does not find it a difficult fish to catch and a large one will resist like a good-sized Pickerel.

The Sauger, also called Sand Pike, is a little brother to the Pike-perch, resembling it in general appearance, but in size does not average more than a quarter of its weight. It has a smaller eye, a more pointed head, and a lighter coloration. It has much the same geographic distribution.

The Sauger is a good food and game fish, taken in trolling and casting both with bait and lure. In some localities great numbers are taken with seines.

COMMON EEL (*Anguilla rostrata*)

(For illustration see Color Plate, page 126)

The annual catch of Eels for market along the Atlantic coast from Maine to Florida exceeds 3,000,000 pounds and is worth \$250,000.

Recently three barges, each more than 100 feet long and 12 feet wide, arrived at New York from Quebec with 165,000 pounds of live Eels. They were towed by way of the St. Lawrence River, Lake Champlain, and Hudson River and were 13 days in transit. The barges are virtually well-boats, or live cars, the bottoms consisting of heavy

slats, with narrow spaces between to provide abundant circulation of water.

The catch is made when Eels are working toward salt water and is heaviest during the dark of the moon. The season is from July to October, inclusive.

Large as is the catch of Eels in America, it is vastly greater in Europe.

Science knows more to-day about the Eel than it did some years ago, and the missing chapters in the Eel's life history have been supplied through modern deep-sea investigations rather than in the study of fresh or coastal waters, where Eels are more in evidence.

Unlike Salmon, Shad, and other fishes which enter fresh waters to spawn, the Eel descends streams at maturity to spawn far at sea. The young Eels—three inches or so in length, called Elvers—that enter fresh waters in the spring in large numbers, and are continually working upstream, have always been known, but the stages of growth between the egg and the Elver were not.

These stages in which the baby Eel does not exceed three inches in length are of comparatively recent discovery. We here find it a thin, flattened creature, so transparent that ordinary print may be clearly read through its body. When first described in this stage it was called *Leptocephalus* and was not known to be the Common Eel.

These transparent larval Eels found at sea in the winter months grow rapidly, and by the end of the year are more than two inches long, when they begin to transform. By the time they are a year old they begin to appear in fresh-water streams as Elvers or young Eels about three inches long.

Investigations by the Danish vessel *Dana* in 1920 and 1921 have shown that the early larval stages of both the American and the European Eel are found only in the western Atlantic, at depths of 600 to 900 feet. The former spawns to the south and southwest of the Bermuda Islands, the latter to the south and southeast.

While the American Eel begins to enter fresh water at the age of a year, the European species remains three years in the larval stages before it appears as the Elver in European streams. The latter, like the American Eel, goes far inland, even passing within the borders of Switzerland.

Females with ripe eggs are unknown, the millions of undeveloped eggs carried by each female not developing while the Eels linger in fresh or coastal waters.

The Eels found far inland are always females and remain in fresh water for several years. It is only when tending toward reproductive maturity that they seek the sea. Male Eels remain in tidal waters and are smaller and less in evidence. Like females, they do not reach breeding maturity until they have passed to sea.

The great bulk of the Eel catch everywhere consists of females. It is said that all the Eels captured in the great Quebec fishery are females moving downstream.

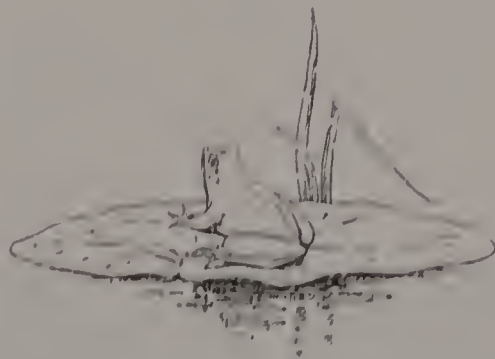
The Eel catch in the St. Lawrence River is derived from Eels belonging to that river and its tributaries, including Lake Ontario. The Lake Ontario catch of Eels in 1899 exceeded 123,000 pounds. The annual yield of all the other Great Lakes combined seldom exceed 2,000 pounds, the Falls of Niagara constituting an impassable barrier to all kinds of fishes.

Enormous numbers of young Eels gather below Niagara in spring and summer, but there is no evidence that they ever pass farther by that route.

The Eels of the upper Lakes may pass up by way of the Erie and Welland canals. It may be that limited numbers of Eels in the Mississippi River find means of passing into the Great Lakes. Whether Eels inhabited these lakes before the construction of canals, the writer is not informed. The fishery statistics at hand contain no records of Eels in Lake Superior.

Eels enter all American streams from the St. Lawrence River to the Gulf of Mexico. It is only the young Eels that move upstream. Adults move downstream and do not return. Both males and females die at sea after the first and only breeding season in their lives. The Eel is very prolific, each female producing from 5,000,000 to 10,000,000 eggs.

Eels are taken in other ways than with nets. "Bobbing for Eels" is done with worms strung on thread, which looped in a small bunch make a bait very attractive to Eels. They are also taken in small wire traps called eelpots, by eelspears, and are even taken by digging and spearing in the mud, where they bury themselves in winter.





Painted by Hashime Murayama

SPOTTED CATFISH (*Ictalurus punctatus*) [at top]; COMMON BULLHEAD (*Ameiurus nebulosus*)
[in middle at left], AND OTHER CATFISHES

There are many kinds of Catfishes in our waters, and they are abundant enough to be of considerable importance in the supply of food fishes. The annual catch for market has been known to exceed 14,000,000 pounds. Great numbers are also taken everywhere with hook and line.



Painted by Hashime Murayama
LARGE-MOUTH BLACK BASS (*Micropterus salmoides*) [upper]; SMALL-MOUTH BLACK BASS (*Micropterus dolomieu*) [lower]

The Black Basses are both well-known anglers' fishes, the Small-mouth species being by far the gamier of the two. Although closely related, they are easily distinguished by the size of the mouth and by the color pattern; in the Small-mouth Bass the upper jaw does not extend beyond the eye as in the Large-mouth species. In the former the color markings tend to form vertical bands, while the latter has a dark stripe along the side.



Hashime Murayama

Painted by Hashime Murayama

ROCK BASS (*Ambloplites rupestris*)

This fish is well known in the Mississippi Valley and the States bordering on the Great Lakes. It is valued for both food and sport. Great numbers are taken by amateur fishermen wherever it abounds, and it can be caught during the greater part of the year. A couple of fair-sized Rock Bass will fill the frying pan. A name often applied to this fish is "Red-eye."



Painted by Hashime Murayama

CRAPPIE (*Pomoxis annularis*) [upper]; CALICO BASS (*Pomoxis sparoides*) [lower]

These fishes belong chiefly to the Great Lakes region and the Mississippi Valley. They are much alike in appearance, but the Calico Bass has seven or eight dorsal spines, while the Crappie has five or six. Both are fine sport fishes and both are handicapped with many local names.



Hashime Murayama

Painted by Hashime Murayama

WHITE PERCH (*Morone americana*)

The White Perch belongs to the Atlantic coast region, and is one of the few fishes that live in both fresh and salt waters. It not only ranges far up the rivers, but is taken in abundance by net fishermen along the coast. The White Perch is good eating whether from fresh or salt water and anglers take it with all sorts of baits. It sometimes reaches a weight of two pounds.



Hashime Murayama

Painted by Hashime Murayama

BROOK TROUT (*Salvelinus fontinalis*)

This is doubtless America's favorite game fish and the one most written about. It is not only much sought by anglers, but is raised by fish-culturists for the fancy price it brings in the market. Overfishing, deforestation and water pollution all contribute toward the steady reduction of its numbers and the restriction of its range.



Hashime Murayama

Painted by Hashime Murayama

LAKE TROUT (*Cristivomer namaycush*)

This is the largest of all Trouts, having been known to reach a weight of 100 pounds. It ranks next to the Whitefish in commercial importance; the total annual catch in the Great Lakes recently exceeded 13,000,000 pounds. Anglers take many in the lakes of Maine, where it is called "Togue."



Painted by Hashime Murayama

McCLOUD RIVER RAINBOW TROUT (*Salmo irideus shasta*)

The Rainbow has been introduced into most of the Eastern States. It is larger than the Brook Trout and can live in warmer water. Although anglers do not consider it quite so gamy, it is a valuable sport and food fish, especially useful in stocking waters no longer suitable for Brook Trout.



Hashime Murayama

Painted by Hashime Murayama

PIKE (*Esox lucius*) [upper]; EASTERN PICKEREL (*Esox reticulatus*) [lower]

The Pike of North America is probably not distinct from the Pike of the Old World. Specimens have been taken weighing over 40 pounds. The Eastern Pickerel is the largest of our three species. Both Pike and Pickerel are valued as food and game fishes and like the Muskellunge are exceedingly voracious.



LAKE STURGEON (*Acipenser rubicundus*)

Painted by Hashime Murayama

The history of the Sturgeon is a story of wanton waste. When the fisheries of the Great Lakes were first being exploited, the Sturgeon was destroyed as useless. Now that its great value is recognized, it may be too late to save it from extinction, as fish-culturists have not been able to solve the problems connected with its propagation. The Sturgeon is valued chiefly for the caviar made from its eggs.

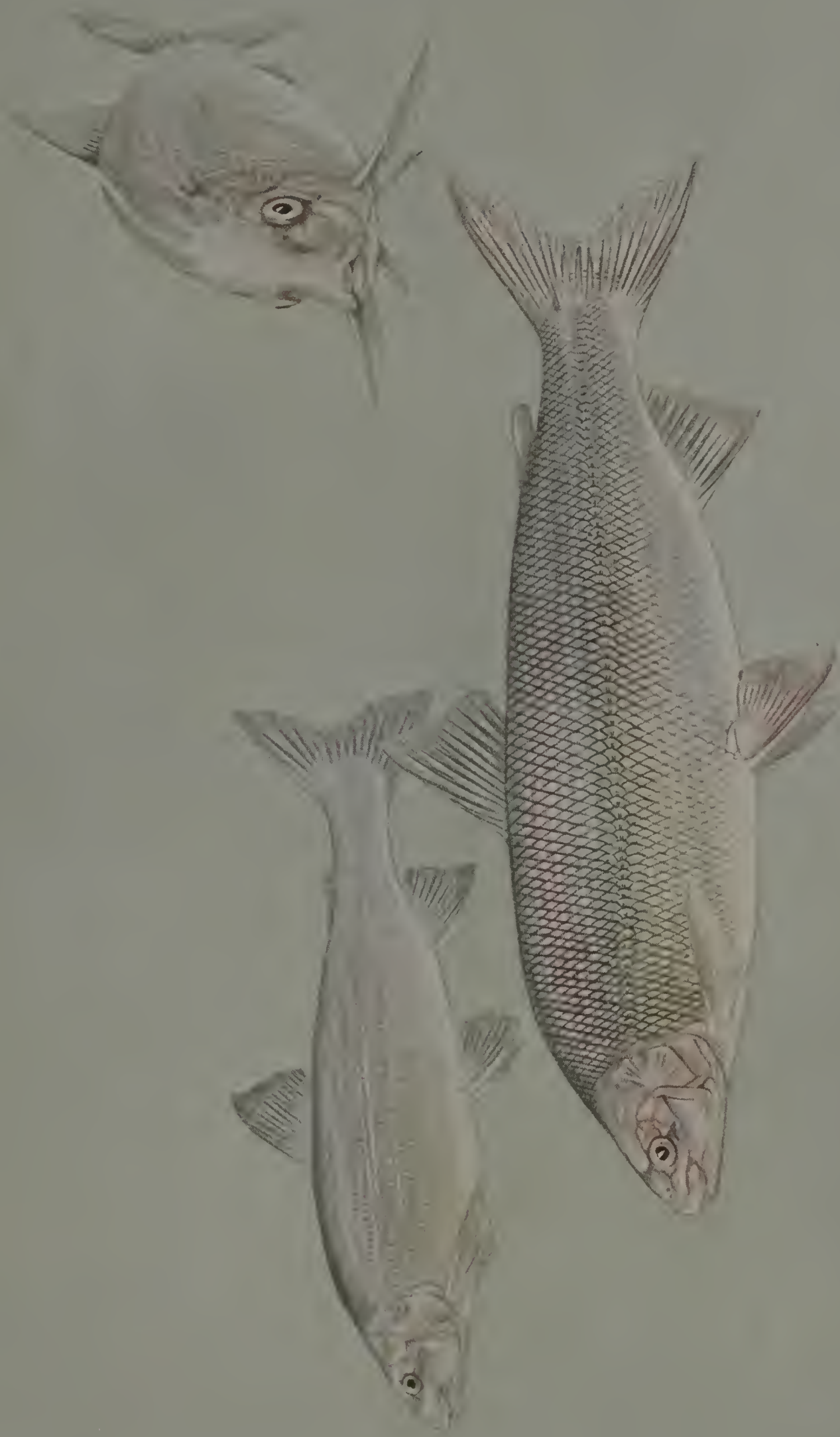


Hashime Murayama

Painted by Hashime Murayama

LAKE CHAUTAUQUA MUSKELLUNGE (*Esox ohioensis*)

There are three species of Muskellunge, the one shown here inhabiting Lake Chautauqua and the upper Ohio River system. All are Northern fishes, much alike in habits. The Muskellunge is the largest of the Pike family and in the Great Lakes has been known to exceed 80 pounds in weight. It is celebrated as a game fish having both size and strength. In bringing to gaff a large Muskellunge, the angler must put all his dexterity into full play.



Hashime Murayama

COMMON WHITEFISH (*Coregonus clupeiformis*)

Painted by Hashime Murayama

This is one of the most abundant and valuable of our food fishes, and with other Whitefishes, one of the most important fresh-water fishes in the world. Over 12,000,000 pounds of Whitefish have been taken in the Great Lakes in a single year. The Whitefish is the subject of extensive propagation by the Government.



Hashime Murayama

Painted by Hashime Murayama

FRESH-WATER DRUM (*Aplodinotus grunniens*)

This large fish of the Great Lakes and the Mississippi Valley is of considerable importance in the market fisheries, but of little interest to anglers except in the South. It is related to the Sea Drum and makes the same drumming sounds. It has heavy grinding teeth like the sea variety and feeds chiefly on Mollusks and Crayfish. Anglers take it best with Crayfish bait.



Hashime Murayama

Painted by Hashime Murayama

YELLOW PERCH (*Perca flavescens*)

Found throughout the Northern and Eastern States, this is one of our best-known fishés. It is caught by anglers of all ages, and great quantities are taken for market with nets. Among the commoner fishes there is none of better flavor. It comes as near being everybody's fish as any other.



Painted by Hashime Murayama

SAUGER (*Stizostedion canadense*) [upper]; PIKE-PERCH (*Stizostedion vitreum*) [lower]

The Pike-perch, often called "Wall-eyed Pike," belongs to the Perch family, although its form is suggestive of the Pikes. It has been known to reach a length of three feet. In commercial importance, it ranks next to the Whitefish and the Lake Trout, millions of pounds being taken in the net fisheries of the Great Lakes. Anglers find the Pike-perch a good game fish. The young are liberated from Government hatcheries by hundreds of millions. The Sauger has the same northerly distribution as the Pike-perch. It resembles it in appearance, but is smaller and of less commercial importance.



COMMON EEL (*Anguilla rostrata*)

Painted by Hashime Murayama

The Eel is a fish that spends its long life in fresh water, descending to the sea in old age to spawn but once and die. For centuries its mysterious ways have puzzled naturalists who have discovered recently that it spawns near the Bermuda Islands in deep water, the transparent larval Eels not seeking the rivers until a year old, when they appear as Elvers working upstream.

Certain Citizens *of* the Warm Sea

By LOUIS L. MOWBRAY

EVEN man's most terrific wars against his fellows have a respite; they are but cataclysms in the normal course of the world; but the battle of fish against fish—furious, quarterless, to the death—is everlasting. So, within the warm balmy waters of the Gulf Stream off the Florida coast, where the lazy waves of the surface seem to typify peace, the never-ending Armageddon of the finny world rises to its highest pitch.

It is almost impossible for the human mind to conceive the continuous struggle for existence that in these warm seas goes on beneath the surface of the water. If such conditions existed on land and the resultant mental strain were not provided for by Nature, few would survive the constant tension upon the nervous system.

A fish starting in pursuit of another frequently attracts the attention of one of a larger species and is in turn pursued. Often, in southern waters, when an angler hooks a fish, and before it can be drawn into the boat, it is cut in two by the jaws of a larger enemy; for most carnivorous fish seem instantly to sense prey when one of their number is in trouble, and a blood lust becomes epidemic forthwith.

LIFE AT A TERRIFIC PACE

The strife of the seas takes many forms. Fishes that feed in shoals have a well-planned method for acquiring their living food, and the same procedure is carried out so often that it resembles the workings of an exceptionally well-trained body of soldiers.

When a shoal of smaller fish is located near the shore, the larger fishes encircle the shoal, herding it to an almost compact mass, occasionally darting into it and getting a mouthful. Sometimes they do not strike the shoal, but continue driving it as bait until somewhat larger fishes attack it. The great fish then proceed to feed upon those which have been lured by the original prey.

During the *mêlée* the surface water is lashed into foam, often for an area exceeding a mile, and the little fellows are jumping every way in their mad efforts to escape their enemies.

Then from the air above comes another menace to the safety of the panic-stricken legions. The seagulls, man-o'-war birds, and pelicans dart upon them as they break the surface in their mad efforts to escape the dangers of the sea.

It is possible to locate a shoal of small fishes by watching the birds which feed from the sea. These fly over the shoal, waiting for the inevitable attack of the larger fishes to drive the food they seek to a point of vantage near the surface of the water.

THE SUPPOSED PASSING OF THE TILEFISH

In addition to sheltering nearly every species of sea creature under the laws of chance by providing extreme prolificness, Nature has not failed to furnish other protective measures to offset somewhat the dangers that everywhere threaten to eliminate whole species.

Numerous cases are recorded where a certain kind of fish has been almost obliterated and for long stretches of time has been thought to be extinct, but in some manner a sufficient number of individuals of the species remained to find protecting shelter where they might live and propagate their kind.

One case is that of the Tilefish, of which much has been written. In the year 1882 vessels arriving in Philadelphia, New York, and Boston reported having passed through miles of dead fish of this species. From the various accounts, it was estimated that an area of from 5,000 to 7,500 square miles was thickly strewn with the dead and dying creatures. The number of fish in this area was computed to be in excess of 1,000,000,000.

Various reasons were advanced for this gigantic tragedy, the most plausible being that a very sudden drop in temperature along the northern edge of the Gulf Stream proved fatal to these warm-water fish.



Photograph by A. W. and Julian A. Dimock

A TARPON DOING A FIN SPRING

This remarkable photograph, taken by Messrs. A. W. and Julian A. Dimock, shows the masterly fight put up by a hundred-pound Tarpon. These huge fighters now and then leap into the boat in their endeavor to shake the hooks from their mouths.



Photograph from Miami Aquarium

BARNACLES ON THE KEEL OF A SHIP IN DRYDOCK

The Barnacle (*Balanus*), sometimes called the acorn Barnacle, is of the crab family, a crustacean which secretes its own lime for its outer covering. Its minute spores when thrown off attach themselves as quickly as possible to some object—a ship's bottom or piling—growing rapidly and attaching one upon another until a stag horn is formed, attaining five or more inches in length. Investigation has determined that dead Barnacles are common carriers of many small fishes, the shell cavity being from two and a half to three inches deep and from three-fourths to one inch in diameter, thus affording a secure touring cabin. So it is that small fish of the Pacific are no doubt transported around the Horn into the Atlantic and to other oceans in the same way. This crustacean causes an annual loss of many millions through the fouling of ships' bottoms and retarding the speed of the world's ocean-going commerce.



Photograph by James A. Allison

FEMALE SAWFISH TAKEN ALIVE

This catch, made with a net, was exhibited for several weeks in a 36-foot tank at the Miami Aquarium. She gave birth to nine young, the only record of sawfish being born in captivity.

It seemed for several years that the species was almost totally wiped out, but recently Tilefish have been rediscovered in great numbers in their former habitat. It is not known where they retired until their numbers became strengthened, but the fact remains that this valuable foodfish is back again in normal numbers.

Among the coral reefs off Florida one frequently sees millions of the fry of some pelagic or surface-swimming, offshore species taking shelter in and about the skeleton ribs and plates of a wreck resting on the ocean bottom, yet easily discernible in the clear southern waters, which offers a harbor for a considerable number seeking safety. Not only does the structure of the abandoned ship provide hiding places, but the Grouper family, which makes the wreck a regular habitat, acts as a guard for the smaller fish against their arch enemies, the Jacks and Yellow Tails, which are in turn sought by the Groupers as food. The fry thus frequently remain unmolested, as they are too small to make food for the Groupers.

When the fry move from place to place, they usually do so at dusk or

through the night, and then on the surface of the sea, where they find their principal food—plankton, the weak floating organisms, and nekton, the actively swimming animal life—which is more plentiful on the surface after the sun's rays are lessened.

A PARADOX OF PROTECTION

Many fishes of the warm seas are chameleon-like in their coloration and take on the color and hue of their surroundings for protection, while others seek the holes and crevices into which the pursuing fish is unable to follow.

Some fishes, to protect their young, carry their eggs in their mouths. Nature has so taken care of other species that they are hermaphrodite. Others live in the gill cavities of a greater fish. Some species of the sucking fish, as an illustration, utilize the gill cavities of larger fishes, such as the Mola, or Giant Sunfish, and the Sailfish, for this purpose.

Many live in other marine animals. The amia, for instance, lives with the animal in the large West Indian Conch (*Strombus gigantus*), whose spiral shell

so beautifully tinted on the inside was frequently used as a fireplace ornament a generation ago. While there finding protection, this little fish carries its eggs in its mouth. Another species, the Fierasferer, lives in the Sea-pudding, one of the Holothurians, or Sea-cucumbers.

Into the battle for and against the multiplication of these species steps man, who, provided with human mind and intellect, looks to the sea for food, diversion, and for useful products of benefit to his kind. Industries have been built up which take countless millions of fishes yearly for food and other commercial uses.

THE LURE OF THE SINGING LINE

It is doubtful if there is any one except the biologist who appreciates the living things in the sea more than do sportsmen, who come in ever-increasing numbers to the fishing grounds for a try at their health-giving, out-of-doors recreation.

The big-game hunter of the land, when coming upon a bull moose standing clear of the woods and providing an excellent opportunity for a shot, will sometimes tremble so that he is unable to pull the trigger. So there is a thrill all its own in the striking of the Tarpon, Sailfish, or some of the other game fishes of the Gulf Stream. It has been said truly that one strike invariably means a convert.

Wary, strong, and of remarkable gameness, it is true that these wonderful fishes try the strength, skill, and endurance of even the best and most experienced angler; and, when the prize is finally landed, the successful one feels all the exultation of one who has waged a mighty battle and won.

While many worship at the shrine of the Tarpon, some of the more experienced sportsmen, equipped with light tackle, esteem just as highly, if not a grade higher, the gameness of other fighters of the warm seas, such as the Sailfish, the Wahoo, and the Bonefish. The Bonefish of recent years has become particularly popular among sportsmen, and world-wise anglers journey even from Europe to Florida to match their ability with this animated steel spring.

The Tarpon is abundant in Florida waters, on both coasts, where hundreds of sportsmen, winter and summer, seek it for the thrill and pride of capture it pro-



Photograph by Van Campen Heilner

THE SOUTHERN PORPOISE, SOMETIMES ERRONEOUSLY CALLED THE DOLPHIN

The great flats of the Bay of Florida is one of the favorite feeding grounds of this swift and graceful fish. When harpooned it puts up a long and thrilling battle.



Undersea Photograph by Dr. W. H. Longley

UNDERSEA STUDY OF A FAMILY GROUP OF YELLOW GRUNTS

To realize the full value of this amazing photograph, one must remember that these multi-hued fish are at home among the coral and sea-fans of their natural habitat, many feet beneath the surface of the Gulf Stream. The Yellow Grunt is one of the species of fishes which makes a croaking or grunting sound, a fact from which it derives its name. A distinguishing feature of this fish is its bright red or orange color at the base of the jaws and inside the mouth. The color patch is revealed to its fullest extent when the mouth is opened wide in the presence of an enemy, or when it invites the services of the Butterfly fish to enter between its jaws and extract certain parasites attached to the walls of its mouth.



Photograph by A. W. and Julian A. Dimock

TARPON LEAPING

This great fish, the "Silver King," dear to the heart of all sportsmen, was caught by the camera in the very act of shaking the hook from its mouth.

vides. When one is caught with rod and reel, it leaps repeatedly from the water, and as the sunlight plays upon its glistening scales while the angler battles constantly to prevent it from freeing itself during the struggle, the thrill must be experienced to be fully appreciated.

This best-known of the larger game fishes of the sea, called the "Silver King," is bluish on the back, with its under parts and sides a wonderful, glistening silver (Color Plate, page 152). Its scales are large and iridescent and are utilized in the making of numerous fancy articles which find a ready market as souvenirs of the habitat of the Tarpon. Little is known of the breeding habits of the Tarpon, but very young individuals are found in brackish waters, where they remain until strong enough to enter into the life struggle of the deep.

THE SAILFISH A CLOSE COMPETITOR FOR POPULARITY

The Sailfish is considered a highly desirable fish to encounter, for not only is it valued for the resultant sport after being hooked, but it is also highly prized

for the excellent mounted trophy it makes. Many of these fish adorn the home walls and club-rooms of anglers who take pride in their catches (Color Plate, page 154).

It was this fish which afforded the late President Harding and members of his official family their sport when in Miami waters.

Caught with light tackle, such gamesters require considerable skill in the landing, being very strong and of supreme courage. The Tarpon and Sailfish when hooked leap repeatedly many feet into the air in their efforts to free themselves from the hook and are very frequently successful in such ring generalship.

The Sailfish is not only a good sporting fish, but is also of considerable food value as well. This remarkably swift oceanic citizen is of unusual shape; its large, sail-like dorsal fin and its rapier-like spear make it a curiosity much sought after by the angler.

Little is definitely known of the use of the large dorsal fin, but it is not unusual to see it "hoisted" on the still waters of the tropics in the fish's surface dashes after prey. Its likeness to a boat's sail



Photograph by Herbert R. Duckwall

AN OCEAN SUN-FISH, WEIGHT 1,500 POUNDS, CAUGHT IN THE GULF STREAM
MIAMI, FLORIDA



Photograph from Miami Aquarium

A MUTTON FISH BITTEN IN TWO BY A LARGER FISH

Landing half a fish is not a rare experience for sportsmen at Miami, Florida, for the hungry Barracuda is sometimes quicker than the man with the line. This mutton fish was seized and contended for while being hauled into the boat.



Photograph by John Oliver La Gorce

A SCHOOL OF PORPOISE MIGRATING

The Porpoise in great schools move up and down the Atlantic coast during certain periods of the year. They are said to devour their weight in fish every forty-eight hours.

led inevitably to the fish being dubbed by its common name.

The Marlin fish, which is a close relative of the Sailfish and built very much on the same lines, has the sharp, protruding snout, but the dorsal fin is much smaller. It is purely a pelagic species. It is an excellent food-fish. The Marlin is not so numerous as the Sailfish, nor does it grow to be as large in Florida waters, but it is gamier, and, like most of the fighting fishes of southern localities, has a penchant for leaping clear of the water in its struggles for freedom (Color Plate, page 157).

THE DOLPHIN OF THE MARINER NOT THE FISH OF THE ANCIENTS

Of the game fishes the Dolphin must be mentioned in the front rank. Much has been told of this wonderful species, and by the speed-loving American it is looked upon as one of the greatest of fishes, for there is probably no other citizen of the deep which travels so swiftly. It spends its entire life in the open seas. While idling, its movements are sluggish, but when in quest of its prey it moves with incredible rapidity, and to one observing

its movements it appears like nothing so much as a dash of color in the sea—a yellow-blue-whitish streak that is almost lost in the green water (Color Plate, page 150).

Of all deep-water fishes, the Dolphin possesses the greatest power to change its color. A dying Dolphin affords a most beautiful and spectacular sight, when, with all the iridescence of an opal, it changes hue so rapidly that the brain cannot grasp the beauty of one color before another comes into view. In life its general color is a blue or emerald green above, with brighter blue dots showing on the base; the under parts are silvery and the caudal and pectoral fins are a clear yellow. It is an excellent food-fish, but, being not common in quantity, has little commercial value. It is caught usually only by chance, when one is fishing for other game fishes which inhabit the regions where the Dolphin lives.

THE BONEFISH, A STEEL SPRING OF THE DEEP

The Bonefish represents a single species, inhabiting all warm and tropical seas. It is considered to be among the most inde-



Photograph from Mrs. Bernard F. Gimbel

A RECORD SAILFISH AND ITS FAIR CAPTOR

The Sailfish ranks with the lordly Tarpon as a trophy par excellence. The great dorsal sail, which it runs up or reefs in a flash, its long rapier-like snout with which it attacks fish prey, great courage as a fighter plus the ability to leap from its natural habitat, high in the air, while endeavoring to shake the hook from its mouth, present a thrilling picture.

fatigable fighters of fishdom, and is a source of much sport to the angler, who will often travel hundreds of miles for an opportunity to match his skill and wits with this fish. Its name is, like most common names of fishes, derived from its most striking feature, in this case an internal one. Its bony structure is similar to that of the Herring.

In the localities where this fish abounds the natives have a way of stretching it

before cooking, so that the bones may be released from the flesh. When cooked properly, after this operation, it provides a fine dish and the bones may be easily drawn out.

The color of the Bonefish is a beautiful glistening silver and the scales are much desired by the natives of the West Indies. In fish-scale work for decorating ladies' costumes the scales of this fish are used. The writer has seen an evening gown made wholly of Bonefish scales which was indeed a thing of beauty. The scales were bored and laid on a fabric base like shingles on a roof. The resultant effect was like that of the natural body of the fish (Color Plate, page 151).

Of all silvery-colored fishes, probably none equals the Moonfish in beauty. These sluggish little fishes frequent shady places and sandy shores, where they are taken in seines in large quantities. To the quiet observer of their habits, they appear to be duly appreciative of the fact that they are admired, for they seem to be forever

cleaning and preening themselves in the sands (Color Plate, page 147).

The peculiar, moon-like contour of the bodies of these fish is mainly responsible for their name. They are literally the "high-brows" of the fish tribe, their high foreheads giving them what passes for the appearance of intellectuality. When seen at close range, the iridescence of their silvery bodies is more beautiful than mother-of-pearl, which the sides of

the fish so closely resemble. They glisten in the sunlight like the sun flash from a mirror. As a food-fish some say they are equally as good as the Pompano, high praise indeed.

Traits which mark land animals, with which man is more familiar than he is with the sea-dwellers, can be traced in the turbulent life under water. Killer-whales travel in packs like wolves and stalk their prey in much the same way. Other fishes, because of their appearance, have been given names to indicate a resemblance to land forms. There is the Dogfish, the Sea Catfish, and the Hogfish; but it is doubtful if ever a fish was given a more appropriate name than the nickname bestowed on the Barracuda.

THE TIGER OF THE SEA

The Barracuda is a carnivorous pirate from the tropical and subtropical regions and has been recorded as reaching a length of eight feet. It is amazingly swift in action, and strikes its prey without hesitation, on sight, darting with lightning rapidity at any moving thing in the sea, big or small, fast or slow. While cruising, its movements are slow and sluggish, and its habit of frequently hiding under some floating log or pinnacle of rock reminds one of a U-boat lurking in the ocean lanes, but ready to strike down the passerby (Color Plate, page 143).

When taken with rod and reel, this fish proves to be a savage fighter. Its teeth are most sinister in appearance, having on each side a sharp, cutting edge, which, with the powerful leverage of its mighty jaws, make it a formidable foe. It will attack almost any kind of sea denizen, its own species included, no matter what the size, and with one snap it can sever the body of an unbelievably large fish. This has been demonstrated often to fishermen, who have had their catch taken by the Barracuda before it could be hauled into the boat.

Natives of tropical waters fear the Barracuda more than the Shark, and with good cause, as is attested by the injuries this fierce fish has inflicted on the bodies of individuals who have been so unfortunate as to be struck by its wicked jaws.

Yet this ferocious creature, like practically all fishes kept in captivity, becomes docile when properly cared for. At the



Photograph from Alfred Sanford

A TARPON WEIGHING 158 POUNDS, TAKEN IN FLORIDA WATERS

The Tarpon is one of the earliest of the large fishes for which American sportsmen angled. Consequently it has been extensively advertised, and therefore is the most widely known of the sea fighters.



Photograph from Miami Aquarium

CURIOSITIES OF THE OCEAN FLOOR

Not white chrysanthemums but giant Anemones very much alive and constantly moving their long petals in search of minute particles of food. The clusters of black hatpins are living Sea-urchins so protected by their movable quills that few marine animals disturb them. The Hermit Crab walks about with his borrowed home, an empty Conch shell, and the Star-fish is much in evidence. The beautiful tinted Sea-fan forming a background for a long-spined Sea-urchin is thriving in a cluster of coral.

Miami Aquarium, so admirably located at Miami Beach, Florida, one of the aquarists, when superintending the cleaning of the tanks, will pet the Barracuda much as a child strokes the back of a pet cat, and the fish will, in a seemingly gentle way, take food from his hand.

FOOD VALUE OF WARM-SEA FISH

In the Florida markets the several members of the Grouper family are highly considered and find a ready market, while in Bermuda these fishes are not looked upon with favor. The Groupers represent one of the largest families of fishes in tropical and subtropical waters. Some of the species reach a length of eight to ten feet and weigh, at times, as much as 600 pounds.

The Black Grouper, which grows to be one of the largest of the family, is extremely wary and is one of the most difficult of fishes to land. When one is still-fishing, this species will sometimes encircle the bait for hours before deciding to take it.

One would imagine that the fish looks its surroundings over very carefully before venturing to take the bait; but, when apparently satisfied that it should take it, the Black Grouper bites at it most viciously and forthwith makes for the nearest hole in the coral reef, and thus it often frees itself by running the line over a sharp edge of the reef. Once the hooked fish reaches a hole, it is almost impossible to bring it again to the surface. Trolling is by far the best way to take the Black Grouper (Color Plate, page 146).

The Nassau Grouper is another large member of the family. It, like the other Groupers, inhabits the coral reefs and lives a solitary life, except during the breeding season, when it is gregarious. During this period it congregates in large shoals, from which habit the family receives its name. The Nassau species changes color with great facility, but during the change a black spot at the base of the tail retains its deep color, no matter what other tints may come and go all over its body (Color Plate, page 145).

The Red Grouper is not, on the average, as large as its Nassau cousin, forty pounds being a high weight for this species. It is a good food-fish and is beau-

tiful in appearance. It has habits similar to the other Groupers (Color Plate, page 145).

The Gag, a smaller-scale Grouper, is not only esteemed as a food-fish wherever it may be found, but is also one of the gamiest of the family. It seldom attains a greater length than four feet. Its habitat is principally along the Florida reefs; it also frequents the Bermudas (Color Plate, page 146).

The gamiest of the Grunts, the Margate fish, is another excellent food-fish, likewise the Mutton-fish, of the Snapper family, which is considered the best fighter of that clan and also the largest representative. Some Mutton-fish reach a weight of as much as 25 pounds (Color Plates, pages 148 and 144).

THE MAJESTIC MACKEREL AND HIS KINGLY COUSIN

Some of the species mentioned are popular only locally, but the Spanish Mackerel is known favorably not only in its own habitat, but wherever shipping facilities are such as to provide for the transportation of this sound, finely flavored fish. Millions of pounds are shipped north annually from the State of Florida alone. From one market, Key West, more than 3,000,000 pounds are shipped each year. They are surface-living fish of great game qualities, elegant in form and color, and among the swiftest fishes of the sea, as their stream-like line and tail indicate. They appear in countless numbers in southern waters from November to March, during which period they are taken in great quantities for the market (Color Plate, page 149).

Associated with the Spanish Mackerel is the Kingfish, which is somewhat larger, on the average. Both belong to the same family and are much alike in many respects. As a food-fish, the Kingfish ranks next to the Spanish Mackerel, and nearly half a million pounds are shipped each year from the Key West markets (Color Plate, page 149).

THE NUMEROUS JACK FAMILY

Most of the fishes referred to are carnivorous and are not frequently seen in the neighboring waters of populated sections. It is by no means a rarity, however, for even the most wary—excepting,



Photograph by John Oliver La Gorce

SWAPPING WHOPPERS

To young and old alike the mystery and lure of fishing is ever beckoning and the teller of fantastic fish stories is always with us.

perhaps, the Dolphin—to frequent the haunts of man.

While wariness is a common trait of game fish, one species, the Jacks, seems to have no fear of man and his traffic. They may often be observed resting lazily, in tidal waters, under a bridge or near the shore, where the traffic is constant. They cruise slowly around, awaiting the approach of their favorite food, the Mullet. When a school of Mullet appears in sight, there is instant action. The Jacks marshal their forces and bear down upon their prey, upon which they wreak spectacular and terrible carnage.

The Amber Jack is the largest and gamiest of its family and inhabits both the shoal and deep waters among the Florida Keys, the West Indies, and Bermuda. It provides excellent sport for trolling and will take almost any kind of live bait offered by still-fishing. It is a carnivorous, surface-living fish of considerable food value in the Bermudas and the West Indies, where large numbers are taken for market purposes. It is not so highly considered in the Florida markets, where its cousin, the Yellow Jack, is more common (Color Plate, page 155).

The Yellow Jack is also a surface-living

fish of graceful lines and beautiful coloration. It resembles the Amber Jack closely, both in habits and appearance, although it does not reach so large a size.

CONTRIBUTING TO THE WORLD'S KNOWLEDGE OF KNOWN FISH

The fishes already mentioned are common in the waters adjacent to the Gulf Stream and are widely known, many miles from their habitat, for their game-ness and sporting qualities or for their food values; but now and then a new Gulf Stream species has been found which requires classification.

Such a find was made in the case of Allison's Tuna. This beautiful fish, of which but a few specimens have been caught, was taken at the edge of the Gulf Stream, off Miami Beach, Florida. It is proved to be a new species added to the American fauna—a species second to none of the other members of the family in coloration and interest. It reaches a large size and will in all probability become one of the fishes most sought for by anglers in the Florida waters. The newness of the fish will doubtless cause sportsmen to vie with one another in their efforts to land a specimen of record size.



Photograph by Dr. W. H. Longley

THE GRAY SNAPPER (*NEOMENIS GRISEUS*) AMONG GORGONIANS



Photograph by L. F. Williams

SWELL (PUFFER) FISH FOUND IN ALL WARM SEAS

To frighten its enemies, this fish is permitted by a considerate Nature to fill itself with air when approached. Sometimes it puffs too much and bursts.

The new Tunas appear to be most numerous in January.

The writer has good cause to believe the reason this fish has not been taken until recently is because the tackle used for the Sailfish and other fishes common in the waters harboring this Tuna was too light to stand the strain put upon it when this powerful fish struck. Many lines and rods have been broken by large fishes in this section, and sharks have been blamed, when unquestionably, in a great many cases, it was the newly discovered Tuna.

The *Thunnus allisoni* is, like the others of the genus, a warm-blooded fish and its flesh is of fine quality and flavor.

Reptiles as well as fish have found the Gulf Stream a kindly habitat; but Turtles, probably the most valuable of reptiles, are diminishing rapidly in many of the localities bathed by this great stream of warm water where they were formerly abundant. During the period of slavery it is said that many negroes were prompted to try to escape, in some sections of the South, because they were compelled to subsist mainly on a diet of Terrapin. Now Terrapin is a much-sought-for delicacy, difficult to obtain. And what is true of the Terrapin is also true of practically all other turtles.

Without doubt, the Green Turtle is the finest-flavored of the sea turtles and the most highly esteemed as food. It is an herbivorous feeder, inhabiting the open seas in the West Indies, the Bahamas, Brazil, the Gulf of Mexico, the Pacific Ocean, and the Straits of Florida, although it is now almost extinct in Florida waters. The greatest numbers are taken off the Mosquito Coast of Central America (Color Plate, page 158).

The Green Turtle is a beautiful species, reaching a weight of more than 700 pounds, but averaging considerably less. In captivity it becomes quite tame and thrives on turtle-grass, lettuce, and purslane, or "pusley." It will eat flesh, but lives much better on vegetable foods.

There is danger that these Turtles will be wiped out of existence. They are far less numerous than in past seasons, due to the natives digging the eggs. The female Turtle visits the beaches from April until June to deposit her eggs. This she does by digging a hole to a depth of from 14 to 18 inches in the sand, where

she lays from one to two hundred eggs. On the fourteenth night from the first deposit—on what is known as the second crawl—she returns to lay more eggs close by her first nest.

BIRDS ARE ENEMIES OF THE GREEN TURTLE

Not only do the natives of the islands where the Turtles crawl rob the nests, but they frequently catch the Turtle after she has deposited her eggs, thus wiping out at one stroke both the mother and all her potential progeny.

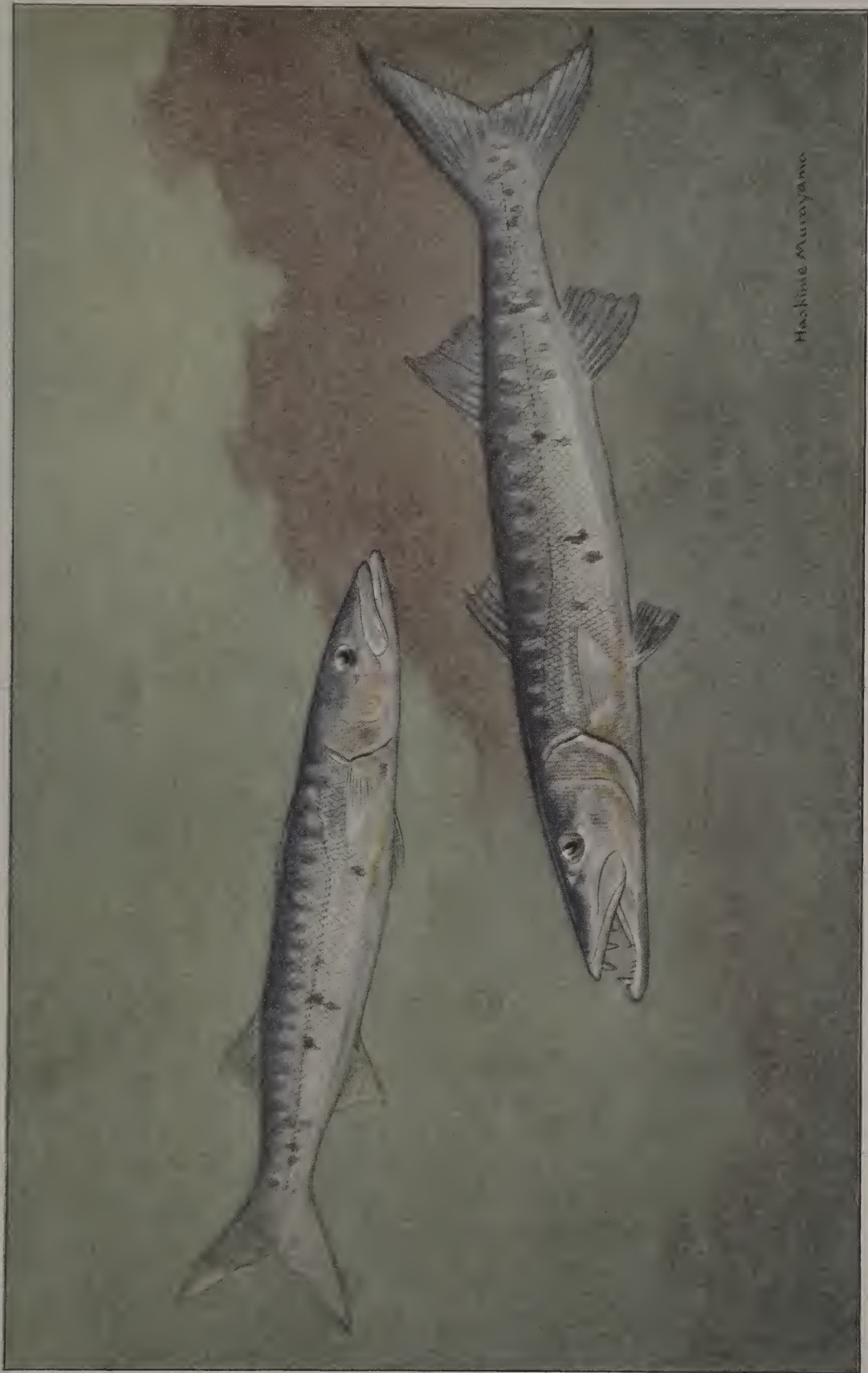
Although statutes covering the protection of the Turtles are written into the laws where these reptiles were formerly plentiful, the marauders continue their work of despoilation. Yet even now between 1,500 and 2,000 Green Turtles are brought annually to the Key West markets, the average weight being 130 pounds.

Man, although the greatest, is only one of the enemies of the turtle. When the young are hatched, they dig to the surface of the sand and immediately make toward the sea. Their instinct in locating the proper direction is unerring, and freshly hatched Turtles, flipped like a coin and turned away from the sea, will wheel around and make directly for the salt water. The Pelican and Man-o'-War Bird swallow the young as soon as they observe the small creatures on their way to the water, and if they reach the water they are harassed by their fellow seawallers.

THE SOURCE OF TORTOISE SHELL

The Hawks-bill, or Shell Turtle, is without question the most beautiful of sea turtles. It is the producer of the much-valued tortoise shell of commerce. This species is found in considerable numbers in the West Indies, where its members deposit their eggs from May to July. It is also distributed throughout the Gulf of Mexico, south to Brazil and the Straits of Florida, although it is now rare in the last-named section to an even greater extent than the Green Turtle. Large quantities of the valuable shell are shipped every year, principally to Europe. The flesh is not as highly esteemed as that of the green turtle, but it is eaten in some localities (Color Plate, page 158).

While the shell turtles are taken principally in large nets, into which they are driven, the natives of the West Indies



Painted by Hashime Murayama

BARRACUDA (*Sphyræna barracuda*)

Well deserving its name of "The Tiger of the Sea," the carnivorous Barracuda darts at its prey on sight and attacks fish many times its own size. Numerous instances are recorded of the Barracuda attacking human beings, and the natives of the West Indies fear it even more than they do the shark. It reaches a length of eight feet or more, and, by many, is considered a good food fish, although individual specimens are reported to be poisonous at certain seasons of the year. It is found in tropical and sub-tropical waters, from Cape Cod south to Bahia and Bermuda, and is common among the Florida Keys.



Painted by Hashime Murayama

MUTTON FISH (*Lutianus analis*)

Living on rocky and grassy bottoms and feeding on small fish and crustaceans, the Mutton Fish is a food fish of great importance, and is taken at Key West in great quantities. It is the gamest fighter of the numerous Snapper family, and reaches a weight of 20 pounds or more. It is found from Pensacola to the West Indies, and south to Brazil.



Hashime Murayama

Painted by Hashime Murayama

RED GROUPE (*Epinephelus morio*) [upper]; NASSAU GROUPE (*Epinephelus striatus*) [lower]

The Red Grouper lives a solitary existence among the coral reefs except during the breeding season, when it becomes gregarious. It is a good food fish and reaches a weight of 40 pounds. Thousands of pounds are annually brought into the Key West markets for local consumption and northern shipment. The species is found on the Atlantic Coast from Virginia south to Rio Janeiro, and is common among the Florida Keys.

The Nassau Grouper is gregarious during the breeding season, when it is taken in great numbers. It reaches a weight of 50 pounds, and is caught with the hook readily, but is not particularly gamy. It has a remarkable power of changing its color. Its habitat is the West Indies, and from Miami to Brazil, being common in the vicinity of Bermuda.



Hashime Murayama

Painted by Hashime Murayama

GAG (*Mycteroperca microlepis*) [upper]; BLACK GROUPEr (*Mycteroperca bonaci*) [lower]

Living among coral reefs, the Gag is one of the commonest of the Grouper or Rock Fish family. It is a good food fish, reaching a weight of 20 pounds or more. It takes the hook readily and is more game than the other species. It is found in the South Atlantic and on the Gulf coast of the United States, from Carolina to Pensacola and Bermuda, and is common among the Florida Keys.

The Black Grouper lives a solitary life among the coral reefs except in the breeding season, when it is gregarious. An excellent food fish, it reaches a weight of 150 pounds or more. It is strong, but not a game fighter. It is abundant about Miami, among the Florida Keys, and is found throughout the West Indies, in Bermuda, and from Pensacola south to Brazil.



Painted by Hashime Murayama

THE MOON FISH (*Selene vomer*)

This highly esteemed food fish, which reaches a length of a foot or more, lives on sandy shores and feeds on small fishes. It is taken in seines in large numbers about the Florida Keys. In appearance it is most beautiful, suggesting mother-of-pearl. It is found in tropical America on both the Atlantic and Pacific Coasts, from Cape Cod to Brazil, and from Lower California to Peru.



Painted by Hashime Murayama

THE MARGATE FISH (*Haemulon album*)

The Margate Fish is a food fish of considerable importance in Florida markets, reaching a weight of ten pounds. It is the largest and gamest fighter of its family. It is found in the Bermudas, West Indies, Florida Keys, and south to Brazil, living on coral and grassy bottoms, and feeding on crustaceans, worms and mollusks.



Painted by Hashime Murayama

SPANISH MACKEREL (*Scomberomorus maculatus*) [lower]; KINGFISH (*Scomberomorus regalis*) [upper two]

Living in warm seas and appearing in large schools in the Gulf of Mexico and on the Carolina coast, the Spanish Mackerel is one of the best, and perhaps the most popular, of American food fishes, averaging from two to three pounds, but reaching a weight of twelve pounds or more. It is found on both coasts of North America, and on the Atlantic seaboard from Cape Ann to Brazil.

The Kingfish, a game fighter on light tackle, is one of the principal food fishes of the Florida coast, attaining a length of five feet and a weight of 100 pounds, with an average weight of from ten to fifteen pounds. The rows of yellow spots on the sides of the young disappear in the adult. The Kingfish is found in tropical Atlantic waters, the Gulf of Mexico, and the coast of Africa and Brazil, coming to the Florida Keys in vast numbers in the winter months.



Hashime Murayama

Painted by Hashime Murayama

THE DOLPHIN (*Coryphaena hippurus*)

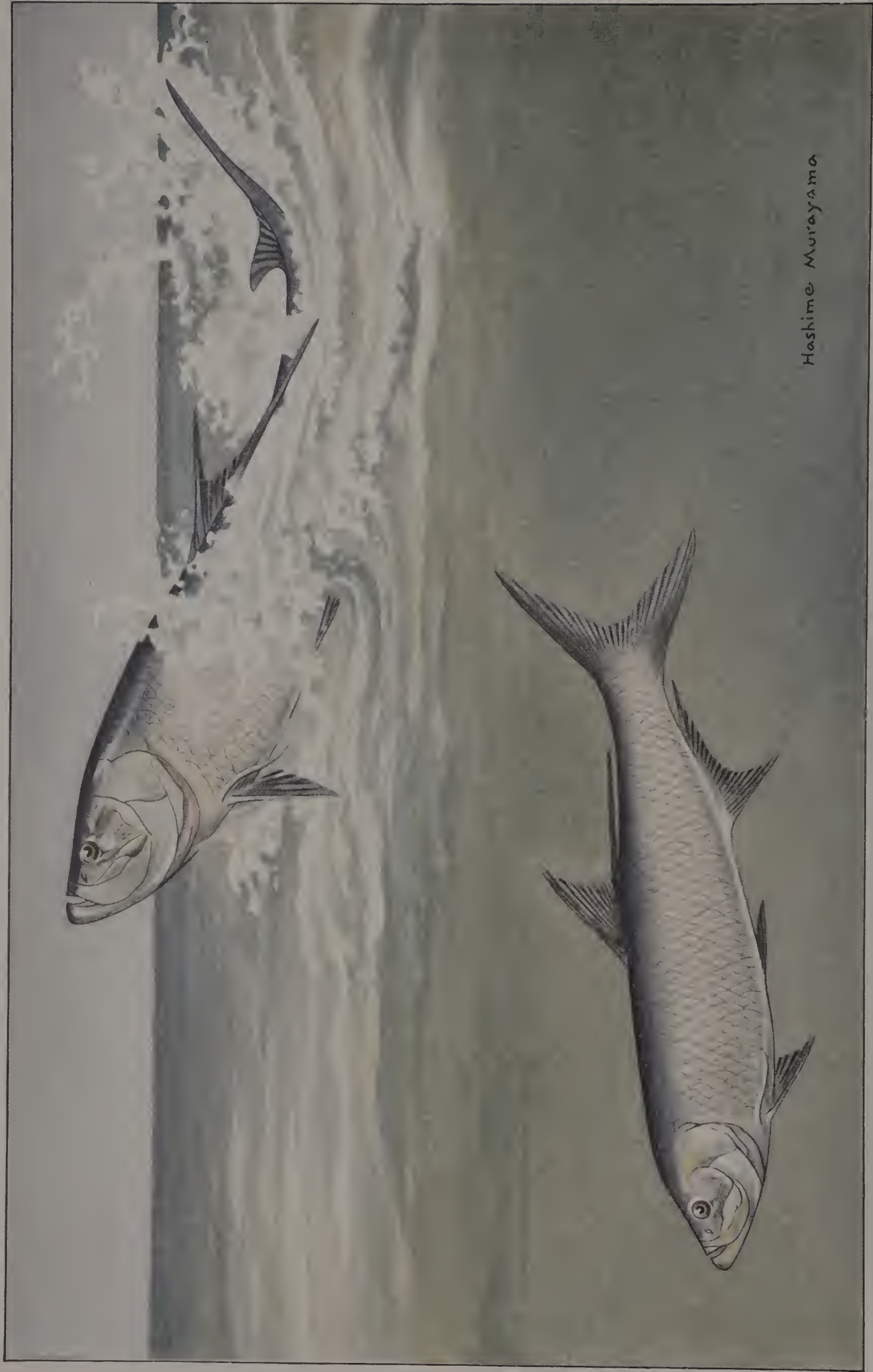
Of all fishes, the Dolphin is probably the fastest swimmer. When pursuing its prey, which, in the open sea, consists principally of flying fish, it swims under the flying fish, and captures it at the moment when it touches the water. The Dolphin is an excellent food fish, very game when hooked. It reaches a length of six feet and a weight of 75 to 100 pounds. It inhabits the high seas in warm regions, and is taken from Cape Cod to the West Indies. This is the Dolphin of the mariner, not the Dolphin of the ancients, which is a mammal.



Painted by Hashime Murayama

THE BONEFISH (*Albula vulpes*)

This beautiful silvery species when removed from the water glistens in the sunlight like a mirror, and is considered one of the best fighters on light tackle, small Hermit crabs being used as bait. It is a food fish much esteemed in the West Indies, reaching a length of three feet. It is found in tropical seas, and is common in the Bahamas and the Florida Keys, living on sandy and muddy shores and feeding on crustaceans and worms.



TARPON OR SILVER KING (*Tarpon atlanticus*)

Painted by Hashime Murayama

To the salt water angler, the Tarpon is the most sought after of all game fishes. As it dashes about and leaps from the water, trying to shake itself free from the hook, its large scales glisten in the sunlight like molten silver. The Tarpon reaches a length of more than eight feet and a weight of 200 pounds. It is not considered a good food fish, the flesh being dry and coarse. It lives among the Florida Keys, in bays about the entrance of rivers, sometimes entering the rivers for a considerable distance, and frequents brackish waters. Little is known of its breeding habits. It feeds on small fishes, mullet being considered the best bait, and is found from Long Island south to Brazil, in the West Indies, and on the east and west coasts of Florida.



Painted by Hashime Murayama

THE CRAWFISH OR SPINY LOBSTER (*Panulirus argus*)

A shell fish of great importance, the flesh of the Crawfish, which has a most delicate flavor, is highly esteemed as food, and is excellent bait, being taken by almost all Florida fish. It sometimes attains a length of 18 inches not including the long whip-like antennae, but averages ten inches. The illustration shows the male and female. The female (on the left) has a small pinching claw on the last leg, which is used to comb the eggs and free them from foreign substances, as well as to remove the dead eggs. Thousands of pounds of Crawfish are marketed annually in Florida alone. It is found in the West Indies, the Bermudas, and the Florida Keys. It lives among the rocks in salt water, and feeds on mollusks.



Painted by Hashime Murayama

SAILFISH (*Istiophorus nigricans*)

Much sought for by anglers, as its game qualities are second to none, the Sailfish is an excellent food fish and reaches a length of eight feet or more, and a weight of 150 pounds. It inhabits warm seas, and is common in the Florida Straits.



Painted by Hashime Murayama

AMBER JACK (*Seriola dumerili*) [upper]; YELLOW JACK OR RUNNER (*Caranx ruber*) [lower]

Living near the surface of the water and often frequenting old wrecks and open waterways, the Amber Jack is common among the Florida Keys. It feeds on small fishes and mollusks, and takes the hook readily, being unexcelled as a fighter. It attains a length of five or six feet, and a weight of 100 pounds or more, and is a good food fish. It is found off the coast of Florida, the Bermudas, and the West Indies, south to Brazil, and as far north as New Jersey.

The Yellow Jack lives in the open waters, bays, and inlets, and feeds on small fishes and mollusks. It is a game fish of rich flavor, and reaches a weight of ten or twelve pounds. The name *ruber* (red) is misapplied, as it never has this hue. It is found in the West Indies, Bermuda, and north to Woods Hole, being common among the Florida Keys.



Painted by Hashime Murayama

OCTOPUS (*Octopus americanus*)

This weird creature, a familiar figure of sea fiction and romance, is most repulsive, having a large ugly head and a fierce-looking mouth, armed with powerful horny jaws similar to a parrot's beak. Its close-set eyes are capable of sending forth a demoniac glare when the creature is angered. The grotesque head is mounted on an oval body from which radiate eight arms provided with suckers. Large Octopus have been known to spread their limbs 14 feet.

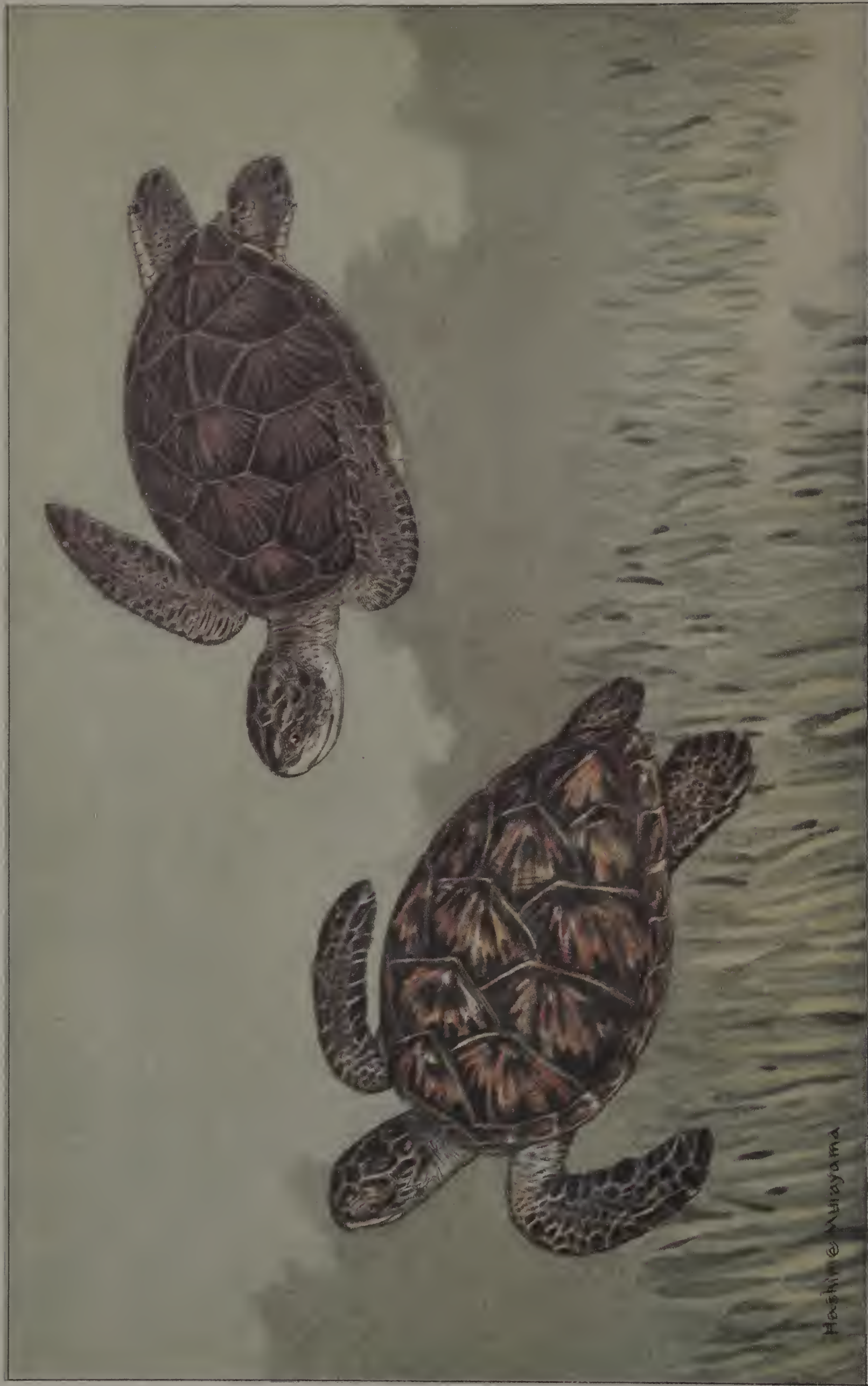


Hashime Murayama

Painted by Hashime Murayama

MARLIN OR SPEARFISH (*Tetrapturus imperator*)

Not as frequent as the Sailfish on the Florida coast, the Marlin is easily distinguished from the former by its low dorsal fin. It is a very game fish and esteemed as food. It reaches a length of eight feet or more, and a weight of 100 pounds. Its habitat is the West Indies, but it occasionally ranges as far north as Cape Cod.



Painted by Hashime Murayama

GREEN TURTLE (*Chelonia mydas*) [upper]; HAWKSBILL TURTLE (*Eretmochelys imbricata*) [lower]

The Green Turtle is most highly prized as food, having no equal among the Sea Turtles. It reaches a weight of seven hundred pounds or more, but has an average weight of fifty pounds. It is herbivorous, feeding on marine plants, especially Turtle Grass (*Zostera marina*). It is found in the West Indies, off the coast of Florida, Bermuda, Ascension Island, Mosquito Coast, the Bahamas, and Brazil.

The Hawksbill Turtle furnishes the tortoise-shell of commerce, hence its high economic value. Great quantities of its shell come from the West Indies annually. The flesh is not so highly esteemed as that of the Green Turtle. It has an average weight of 30 to 40 pounds, but 200-pound specimens have been taken. It lives on fish, crustaceans, and mollusks, among coral reefs of Florida and Bermuda, the Gulf of Mexico, as far south as Brazil.

have another method of catching them, known as "bullying." They drop over a sleeping turtle the "bully," an iron hoop four feet in diameter covered with a net like the crown of a hat. The Turtle becomes entangled in the meshes and is then easily brought to the surface.

When alarmed, the Turtle will hide its head, much as the Ostrich is said to do, and then considers itself quite safe from observation. At the Miami Aquarium one of the turtle specimens has found a conveniently located hole in the rocks of its tank and spends most of the time with its head thrust in the opening, its body dangling outside. Scores of times visitors have rushed to the office of the director to inform him that one of his prize specimens was caught in a crevice and was strangling to death.

THE CRAWFISH, PRIZED COUSIN OF THE NORTHERN LOBSTER

Crustaceans play no mean part in the life of the sea. They cover a wide range in size, from the most minute of creatures to the great Japanese Crab of the western Pacific, whose claws have a spread of 15 or 16 feet. High in the rank of the American crustaceans stands the Crawfish or Spiny Lobster (*Panulirus argus*), of southern salt waters. It is smaller but of even a more delicate flavor than its northern cousin (*Homarus americanus*). This species should not be confounded with the fresh-water Crawfish, which is an entirely different form.

The *Panulirus argus*, or Southern Lobster, is one of the largest of the crustaceans known to inhabit the Atlantic, the Mediterranean and Caribbean seas and is generally conceded to be the most toothsome. Reaching at times the extreme length of four feet, the Crawfish provides an abundance of food material. Large numbers are shipped every year from the Florida markets. It dwells among the coral reefs and heads and is usually caught in traps baited with small fish, although "bullying" and spearing are also practiced to some extent (Color Plate, page 153).

The Crawfish is not only a delicacy

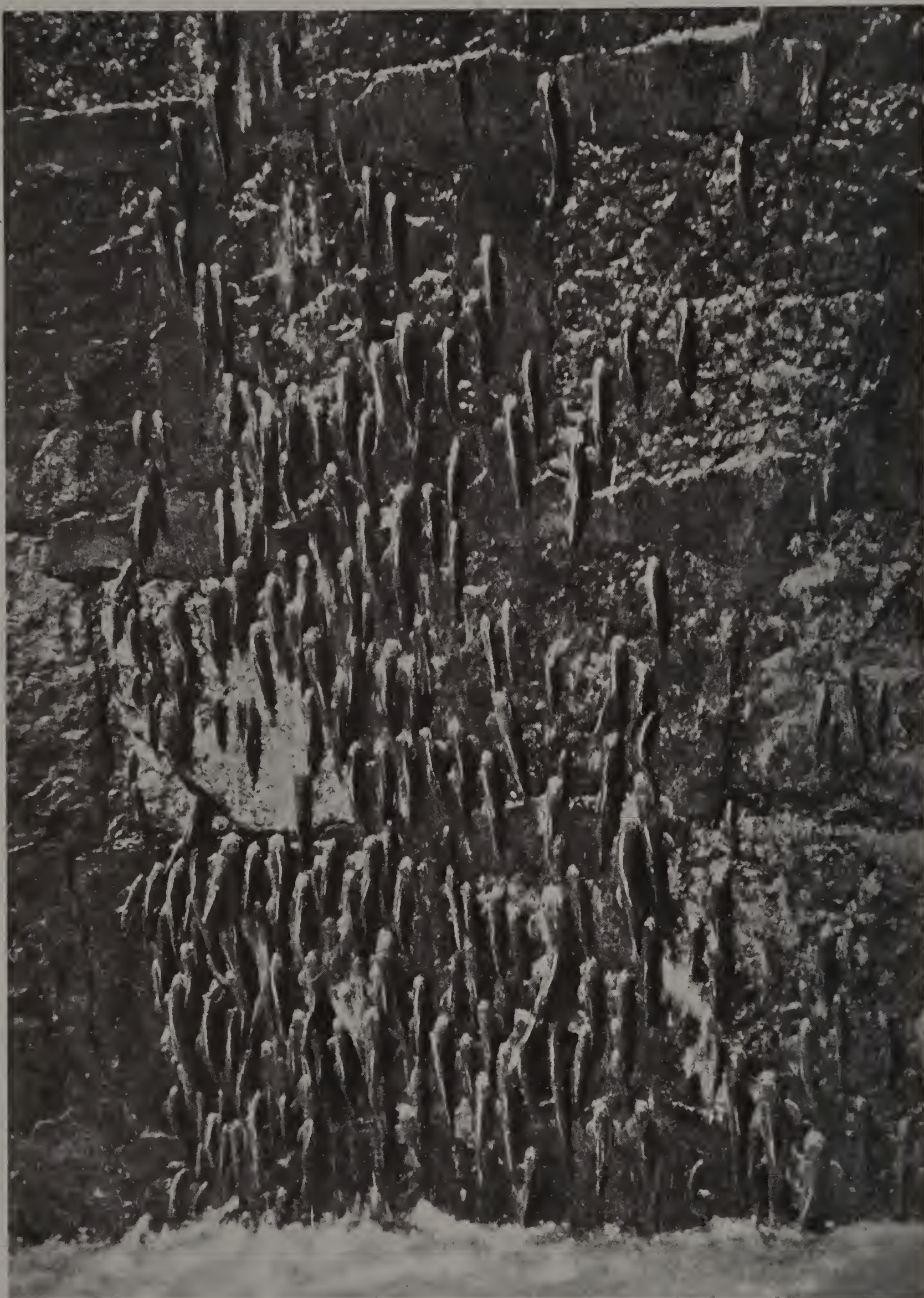
from the standpoint of human consumption, but is relished, too, by the inhabitants of the sea and is an excellent bait for most fish in the Florida waters. In the Miami Aquarium it is the staple food for nearly all kinds of fishes. Even the most purely herbivorous fishes eat, and appear to relish, the fine white flesh of the Crawfish.

Crawfish are easily kept in an aquarium and make an interesting exhibit. This is true particularly of the female during the spawning season, when she is busy, almost constantly, combing her eggs in her efforts to give her prospective progeny a fair start in the arduous life into which they are about to enter. The figure on the left (Color Plate, page 153) shows a specimen carrying her eggs. On the last leg may be noted a pincer, which is used in removing the dead eggs and debris which may adhere to the egg clusters. Large numbers of the eggs have been hatched and scientifically observed at the Miami Aquarium with a view to increasing this valuable food supply.

At the Aquarium many laboratory tests are made of the structure and composition of marine forms peculiar to local waters. Every stage in the life of fish is studied. Some interesting discoveries have been made, and others will undoubtedly follow, whereby man will benefit. More and more are the peoples of the earth looking to the sea for sustenance and even for leather substitutes and various other products. Science has helped much in garnering the sea's valuable materials for the use of the land's dominant animal.

Whether looked upon merely as potential food in a world in which food is becoming relatively scarcer; as interesting or beautiful creatures worthy of study and admiration, or as furnishing the material for a thrilling sport, the fish of the southern Gulf Stream are receiving more and more attention, from the all-too-small group of distinguished ichthyologists who specialize in this investigation.

Ages before Izaak Walton wrote of the fascination of catching fish only large enough to bob a tiny cork, the lure ex-



Photograph by Illustrations Bureau Illustrated London News

FISH SCALING A SEVEN-FOOT WALL

Pectoral and pelvic fins have been compared to legs and arms. A species of Catfish in India are here shown climbing from the Jumna Canal up to the Jumna River using their pectoral and pelvic fins. It is said these Catfish are provided with a special sucking apparatus which enables them to cling to the wall. The Jumna is the chief tributary of the Upper Ganges. It supplies the waters for the irrigation works of the East and West Jumna Canals.

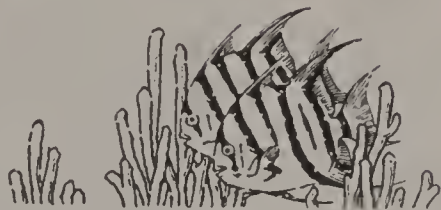


Photograph by Mrs. S. Sanford Procter

FOUR SAWFISH IN TWO HOURS IN MIAMI WATERS

erted by the finny tribe for sport-loving men had been conceded. When the hooking of small fresh-water creatures can bring its joys, is it any wonder that hum-

ble citizen and President alike grow enthusiastic over battles royal with rod and reel in which they match their skill with the great creatures of the Gulf Stream.





Photograph by Herbert R. Duckwald

KILLER WHALE, THE GREAT WOLF OF THE SEA

The ferocity of the "killers" strikes terror to the other warm-blooded animals of the deep. They are known to swallow small Seals and Porpoises entire, and they attack large Whales by tearing away their lips and tongues. When attacking large prey they work in packs. This specimen was captured in the Gulf Stream between Miami Beach and the Bahama Islands by Capt. Charles H. Thompson.

Curious Inhabitants of the Gulf Stream

By DR. JOHN T. NICHOLS, Curator of Recent Fishes

American Museum of Natural History

WE THINK of tropical seas as the home of a gaudily colored assemblage of fishes. In a sense, this first impression is correct. Active, short-bodied, elastic-scaled, spiny-finned, bright-colored species here occupy the center of the stage.

As a matter of fact, tropical shore-lines are the great metropolis of the world's fish life. The evil-visaged snake-like Moray (Color Plate, page 177), one of the most degenerate of true fishes, threads the hidden passages among the coral over which Blue Angel (Color Plate, page 176) and red, green, or parti-colored Parrot-fish (Color Plate, page 182) are swimming.

Out on the open sand, spotted Flounders lie, matching their background so as to be well-nigh invisible, or little Gray Gobies move about like shadows, eager to escape detection.

Countless varieties of fishes are hiding in every patch of weed. Schools of Silversides, Anchovies, and Herring dart through the stretches of open water.

It is their function, in the scheme of things, to feed on the minute organisms so abundant in sea water, to multiply prodigiously, and in turn form a basic food supply for a great variety of larger fishes.

To do this and at the same time contribute something to the forces of evolution, however, their numbers must be conserved. Their silvery sides render them difficult of observation by hungry eyes below, and they are available only to the quick and the keen.

ENORMOUS QUANTITY AND DIVERSITY OF LIFE IN THE GULF STREAM

Over the heat equator warm air is constantly rising. Heavier, cooler air from higher latitudes flows steadily in to take its place, and, deflected by the earth's rotation, becomes the easterly trade winds, before which millions of waves, reflecting the clear deep blue of the ocean depths

under their white crests, go dancing to the westward.

The whole surface of the tropical Atlantic moves, drifting toward the coast of America, is caught and turned about in the Gulf of Mexico, and shoots out past the Keys and the east coast of Florida as the Gulf Stream.

Inasmuch as many young marine fishes and other animals regularly drift in ocean currents, it is easy to understand what an enormous quantity and diversity of life the Gulf Stream must carry.

Furthermore, such waters, when they enter the Gulf, have already flowed under a tropical sun for many, many miles. The Gulf of Mexico is not a place for them to lose calories, and Gulf Stream water has a considerably higher temperature than the 79 degrees found, in general, at the surface of the open ocean on the Equator.

TRULY TROPICAL FISHES IN FLORIDA WATERS

It follows that shores bathed by such water have as truly tropical fishes as if they were situated much farther south.

Essentially the same fishes extend from Florida to Brazil. Scattered representatives of this great tropical fish fauna of the western Atlantic are drifted to the capes of the Carolinas and, to a less extent, in summer, even to New England. We have seen a stray Spade Fish (*Chaetodipterus faber*) (Color Plate, page 176) on the New Jersey coast and a little Butterfly Fish (*Chaetodon ocellatus*) (Color Plate, page 177) washed ashore on the south side of Long Island, New York.

It is a little over ten years ago that the writer made a first trip to Florida. After a prolonged period of more or less distasteful, though necessary, indoor activities during a northern winter, he found himself suddenly foot-loose on the Miami water-front.

The yachting party that he was to join here on a collecting trip among the Keys

was somewhere up the coast, stuck on a sand-bank. Meanwhile, there was nothing to do but sit and swing one's heels.

The first objects of interest were the brown Pelicans flapping by. Why they did not break their necks on the bottom when they dove precipitously from a height into water not more than two or three inches deep, was something of a problem.

FISH THAT WEAR VIVID REDS, GREENS, YELLOW, AND BLUES

But the pelicans were not alone in their ability to see fish. It was soon discovered that a number of interesting species could be observed swimming along the shore. None were more beautiful or as easily identified as the little schools of Pork Fish (Color Plate, page 175), with their bright yellow markings set off by the bold black pattern on head and shoulders. This fish scarcely belongs with the true, gaudy reef fishes, but rather with those less dependent on the protection of the reef, the golds and blues and rose colors of whose livery are often extremely beautiful, yet seldom striking enough to make the fish conspicuous in the water.

By no means all fishes whose haunts are on and among tropical reefs are brightly colored, but there are a great number of active species found there which wear vivid red, green, yellow, blue, orange, etc., and which, furthermore, are marked in the boldest patterns, frequently with black.

Good examples are the Rock Beauty and the Blue Angel-fish (Color Plate, page 176). Various Parrot-fishes, Butterfly-fishes, etc., belong to this class.

Naturalists have offered in explanation that the reef itself was as full of color as a garden of varied flowers, wherein the very brightness of the fishes rendered them inconspicuous. To most observers, however, a coral reef as a whole, appears rather monotonous in tone, the many varied fishes swimming about giving it the principal note of high color, and these are not only easily seen but readily identified.

SOME FISH CAN AFFORD TO BE CON- SPICUOUS

How many northern fishes can one see and recognize as easily, swimming in the

water, as the black and yellow Sergeant Major (Color Plate, page 182), for instance? Granted that, in general, these colors render the fish conspicuous, can they be classed as warning colors, like the black-and-yellow striping of wasps? Apparently not, for there are plenty of predaceous fish which eat some of them and would doubtless be pleased to consume more.

Immunity colors, they have been called most appropriately. The idea is that a wide-awake, active fish on a coral reef has so many avenues of escape from its enemies, so many projections to dodge behind and holes to hide in, as to be practically immune from attack. It can afford to be as conspicuous as it likes.

Be this as it may, the striking patterns are a great convenience to the ichthyologist, who has to separate one species from another, for nowhere else does one find so many different, but closely related, species living side by side, each doubtless differing from the others in habits in some way, be it ever so slightly.

THE NUMEROUS FAMILY OF SEA BASSES

One of the principal families of fishes in our southern fauna is the sea basses, to which the gigantic Jewfish, the rock-fishes, groupers, hinds, and so forth, belong. These are all fishes which resemble our northern Sea Bass. They are big-mouthed and voracious species, living for the most part about rocky or uneven bottom, though also swimming out over open stretches of sand.

Many are food-fishes of importance. They have leathery mouths, so that when once hooked they are not easily lost. Though well formed and by no means sluggish, they are solitary and sedentary, as contrasted with the equally abundant predaceous family of snappers, for instance.

Always lurking on the lookout for smaller fishes to come within striking distance, and sometimes associated in considerable numbers at favorable localities, they do not range about, hunting in schools, like the snappers.

The colors of this group are varied and sometimes extremely beautiful, in none more so than in the small Rock Hind (Color Plate, page 180), whose home is in the bright lights of the coral reef. But



AN OCTOPUS IN ONE OF THE MIAMI AQUARIUM TANKS

The Octopus is a source of fascination to most people in spite of its repulsive appearance. The grotesque head is mounted on a somewhat oval body from which radiate eight arms usually united at the base by a membrane. The arms, or tentacles, are provided with rows of suckers with which to clasp and cling to its prey with uncanny strength and quickness. The Octopus has the faculty of instantly changing color before one's very eyes, and is constantly doing strange and weird things, which always attract the attention of the passer-by.

the plan of coloring is such as to lower, not raise, the visibility of the fish. Contrast, for instance, the color plans of the Rock Hind and the bizarre Rock Beauty.

CHAMELEONS AMONG THE FISHES

These groupers, rock fishes, and hinds, furthermore, have the power of undergoing complete color changes almost instantaneously. The color tone becomes lighter or darker and the markings become bold or fade and disappear. Such color changes can be seen to advantage in individuals kept in an aquarium. There can be no doubt that in the fishes' natural environment they adapt it to the bottom it is swimming over, and, further, that inconspicuousness may aid in its getting a full meal at the expense of its smaller associates.

There is a related fish which has a color pattern almost exactly like that of the Rock Hind, namely, the Spotted Hind. The principal technical difference

between the two is that one has minute scales on its maxillary and the other has not—a characteristic about as obvious to the layman as what the fish is thinking about. The Spotted Hind's squarish tail fin, with a broad, blackish border, affords an amateurish, but simpler, way of telling it.

The fish life of warm shores is one of contrasts. In contrast to the big-mouthed sea basses, there are species, usually sluggish, which have very small mouths, depending for their subsistence on the great abundance of small sea animals found about tropical reefs and ledges, or seaweeds. To capture such small creatures does not require great agility.

The sort of life they lead has probably been taken up gradually, through long periods of time, and many of them have meanwhile acquired remarkable and sometimes quite unfishlike characters of form and structure. None is stranger than the little Sea Horses (Color Plate, page 178), with body encased in rings of



Photograph by John Oliver La Gorce

PROMINENT MEMBER OF THE NUMEROUS RAY FAMILY

The Whip Ray, or Spotted Sting Ray, as he is also known, is now and then seen in the shallow waters adjacent to Miami. The ray uses its broad cephalic fins much as a bird its wings and seems to fly rather than swim through the water. It is beautifully marked with many golden-brown rings. It is not edible.

bony mail, horse-shaped head set at right angles, and prehensile tail to grasp the seaweed where they are hiding, body floating upward erect in the water.

THE MALE SEA HORSE HAS AN INCUBATOR POUCH

The male Sea Horse carries the eggs in a pouch situated under his tail, until they are hatched and the young large enough to fend for themselves.

Sluggish small-mouthed species frequently have hard nipper-like teeth, as the small animals which they eat are many of them shelly.

As it is difficult for them to get out of

the way of larger predaceous fish, they are variously protected against attack, mostly being colored more or less in resemblance to their surroundings. The trigger-fishes have a stout dorsal spine which locks erect, as well as a very thick leathery hide which must be of some protection. The gaudy colors of the Queen Trigger-fish (Color Plate, page 179) are an exception among such forms.

HOW THE SWELL-FISH FRIGHTENS ITS ENEMIES

A somewhat related flat-sided Filefish scarcely swims about at all, but drifts with the tides, more or less head downward, and can be easily captured in the hand. It is so striped as to be readily overlooked, however, among the eel-grass which is drifting with it.

The Swell-fishes have the power of suddenly inflating the body with water or air until they assume an approximately

globular form several times the normal diameter, which must be disconcerting to any enemy about to seize one. The Porcupine-fish, in addition to doing this, has the body everywhere covered with long, sharp spines which project in every direction like the quills of a Hedgehog. Many persons who are familiar with the inflated-skins of Swell-fishes and Porcupine-fish used by the Japanese as picturesque lanterns will be surprised to learn that both are common in local waters.

The Trunk-fishes, instead of being protected in this way, have the body encased in a bony shell, like a Turtle. In



Photograph by E. R. Sanborn, New York Zoölogical Society

A GIANT POSES

One of the largest fishes of the warm seas is the Jewfish which frequently reaches 500 pounds in weight. The tendency of the lens in the eye of a fish to approach the shape of a sphere is clearly shown. The Jewfish is sluggish but very strong.

the East Indies there are rectangular species, but ours are all three-cornered, beechnut-shaped. They go by various names—Cuckold, Shellfish, and so forth, the Cowfish (Color Plate, page 179) being a species with two hornlike spines projecting from its forehead. They are excellent eating, cooked in the shell like a Lobster.

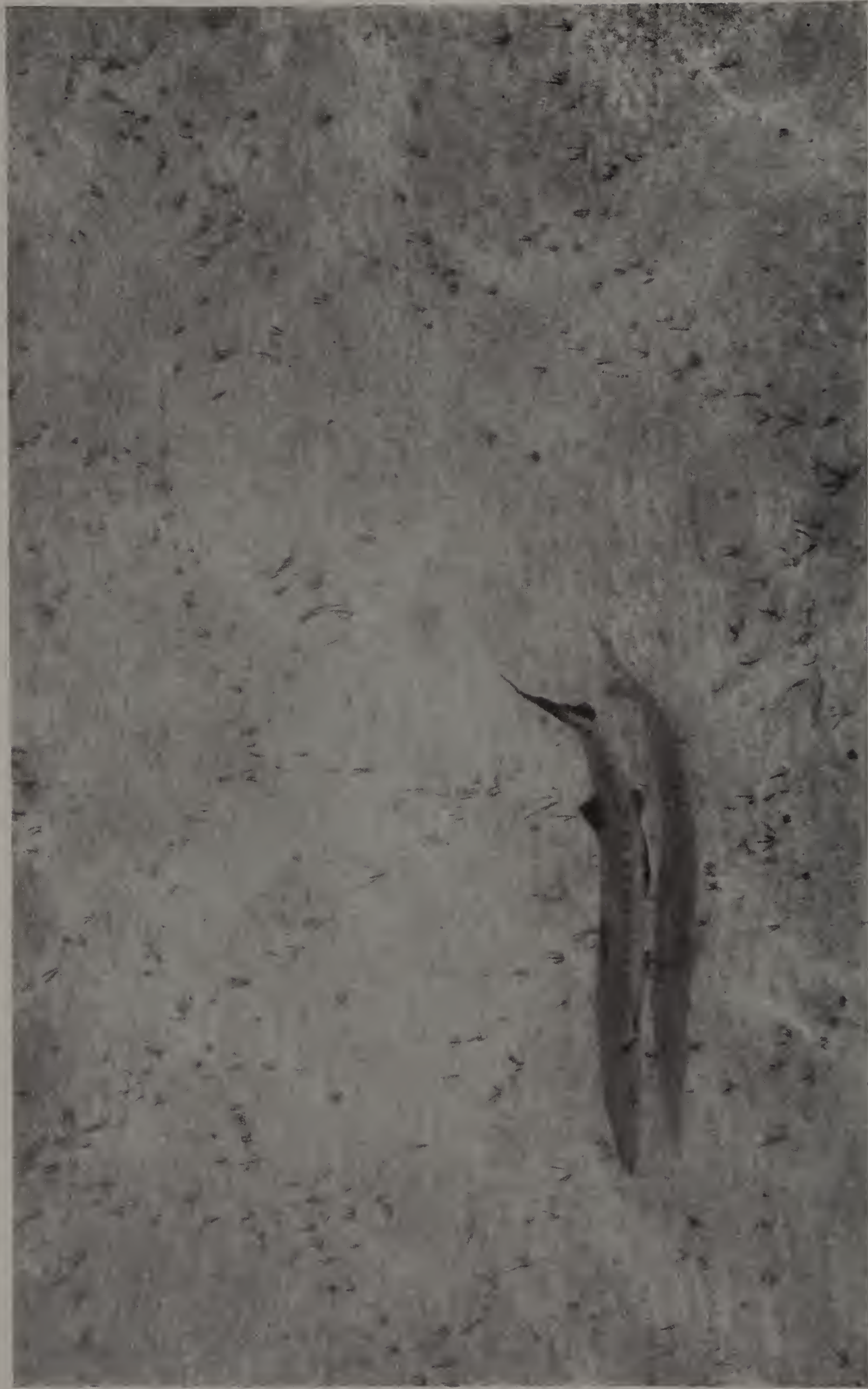
SOME FISH ARE RISKY DELICACIES

The back muscles of the Swell-fishes are sometimes eaten, but make a risky delicacy, as there are well authenticated instances of severe poisoning from eating these fishes. The poison seems to be

localized in the viscera and to permeate the rest of the fish after death.

In some quarters of Japan Swell-fish is highly esteemed when prepared for the table with care, but there is a Japanese proverb to the effect that before eating Swell-fish one should have one's last will and testament in good order.

Poisoning resultant from eating certain species of tropical fishes is a subject which will repay further study. In Cuba several kinds are reputed dangerous and their sale prohibited in the larger markets. Among them are the Great Barracuda, Green Moray and certain species



Photograph by John Oliver La Gorce

THE SEA TIGER—A BARRACUDA

Because of the clarity of the waters of the Gulf Stream and with the ever-occurring carpet of white sand on the bottom to be found along Floridian shores, this unusual photograph of a five-foot Barracuda was obtained by simply holding a kodak over the side of the boat and snapshotting the big fish swimming along six feet or more below the surface. Because of the splendid illumination afforded by the sun on the white sand, even the shadow of the fish, as well as the little tufts of sea flora, was recorded on the plate.



Photograph by John Oliver La Gorce

THE ETERNAL STRUGGLE BENEATH THE SEA

A school of giant Tuna feeding on myriads of Sardines. The Tuna were evidently blood-mad and the white patches of water were occasioned by their great bodies breaking above the surface as they hurled themselves upon their prey. This is a graphic illustration of the never-ending struggle beneath the waves where the big ones eat the little ones, and only the fittest survive. It is also an evidence of Nature's safeguard against over-production of species. The swiftly striking Tuna charging with wide-open mouth causes the little Sardine to jump for his silvery life, but, alas, the instant he shows as much as a fin above the surface low-swinging gulls, attracted from miles around by the disturbed waters, seize him from above. This picture was taken in mid-Gulf Stream and the area covered by the huge school of Sardines was several acres.



Photograph by E. R. Sanborn, New York Zoölogical Society

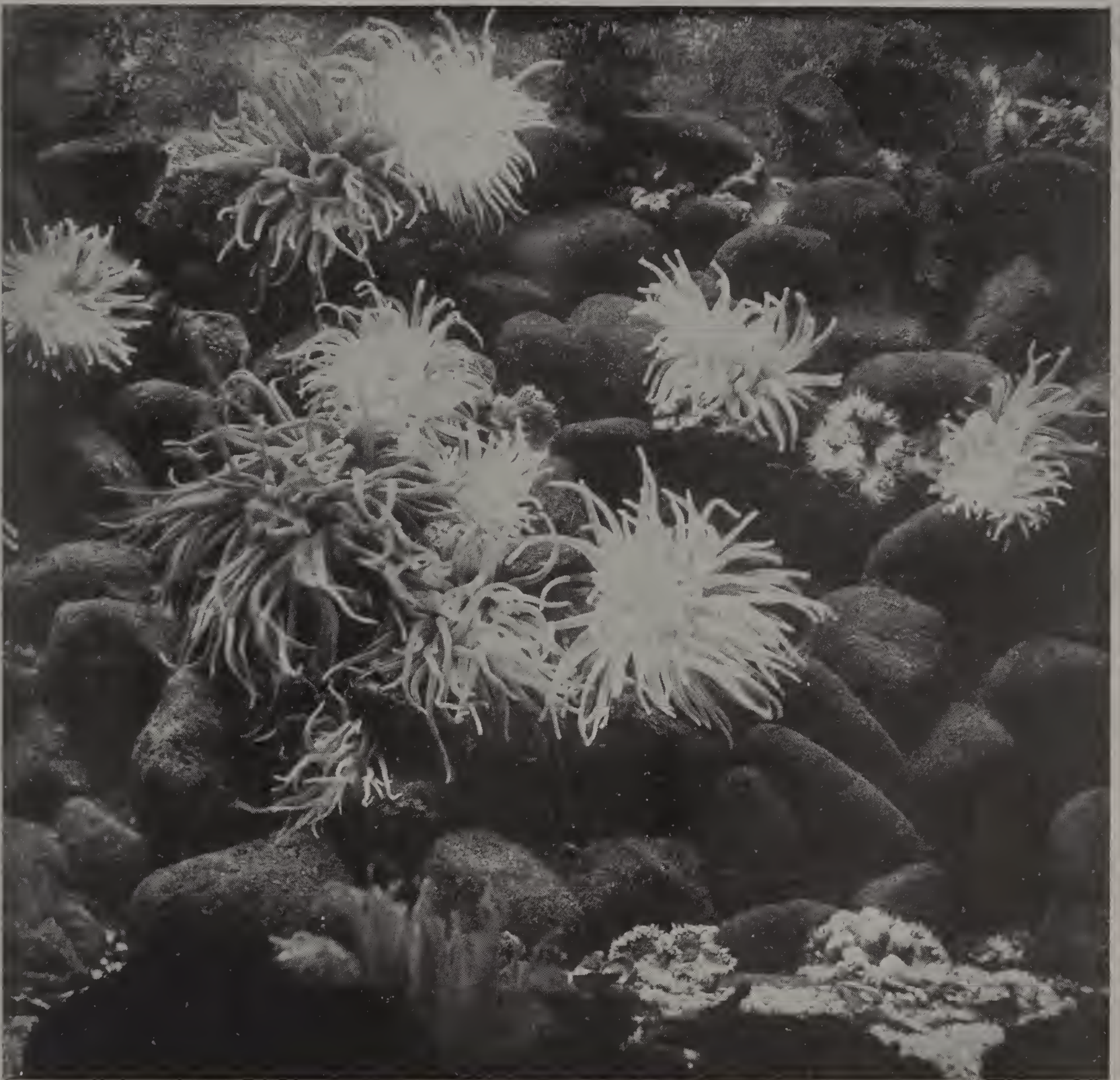
SISTERS UNDER THE SEA

The Porcupine fish above is an uncomfortable mouthful for any hungry undersea hunter, but when it inflates itself into the form of a large ball, its balloon shape and bristling spines, from which it takes its name, offer assuring means of defense against natural enemies. The Spanish Hogfish (below), sometimes called Lady-fish, is beautifully colored and excellently flavored.

of the Carangiidae, or crevally family. On the other hand, this same Barracuda is particularly favored as a food-fish in Porto Rico, as it is known to subsist entirely on clean, live food.

It is said in Cuba that by no means all the fishes of these species are poisonous, and that the smaller ones are safer. The symptoms of poison are sometimes alimentary disorders, sometimes skin troubles. The cause is not known, but Mowbray, writing in the New York Zoölogical Society Bulletin, November, 1916, presents a strong case in favor of the hypothesis that such tropical fish poisoning is in most cases due to improper marketing. He says: "It is probable that if, when caught, the fish were eviscerated and bled, a case of poisoning would be a rarity."

Bulletin No. I of the Madras (India) Fisheries Bureau, 1915, thus emphasizes the importance of properly marketing fish in a tropical climate: "Of all general food, fish is most liable to taint and most poisonous when tainted. . . . Fish not kept alive *must be cleaned and washed at sea* and properly stowed. This brings them to shore with a much decreased chance of taint, even if several hours intervene."



Photograph by L. L. Mowbray

THE WHITE ARMED ANEMONE

Sea-anemones, closely resembling beautiful and many-hued chrysanthemums, are found among the rocks in quiet waters along the Gulf shores. This low form of animal life feeds by arresting with its outspread petal-like tentacles small particles of food floating by, which it then draws toward the central mouth. From a muscular base the anemone can move very slowly from place to place, one observation in the New York Aquarium showing a travel of forty-eight inches in the course of twenty-four hours. They have no food value for man, but are sometimes eaten by fish.

As food-fishes, the snappers are perhaps the most important southern family. A snapper is an all-around, up-to-date fish, an evolutionary product of the keenest of all competition in the fish world, that at the tropical shore-line.

THE WARY GRAY SNAPPER

There is nothing peculiar or freakish about the snapper. He is just thoroughly successful and modern, active, adaptable, and clever—trim-formed, spiny-finned, keen-eyed, smooth-scaled, and strong-toothed.

Almost anywhere one goes one can see little schools of the Gray Snapper through the clear tropical water, skirting the shore or the edge of the mangroves, on the lookout for small fry to satisfy their appetites, and at the same time with a weather eye out for possible danger. It would seem a simple matter to catch one on hook and line, but no fish is warier about being thus ensnared.

Several species of snappers are almost equally abundant, the Muttonfish and the



Photograph by E. R. Sanborn, New York Zoölogical Society

FIFTH AVENUE AND FORTY-SECOND STREET IN THE WARM SEA

On this sidewalk of the sea are Black Angels, Grunts, Jacks, Spadefish, Gray Snapper, Porkfish, Rock Hind and Moray. The Rock Hind, lower right, when resting, use their pectoral fins as stilts after the fashion of an airplane making a "three-point landing."

Red Snapper, which is taken in comparatively deep water, being perhaps the most important commercially.

The excellence of the Red Snapper is widely known, and quantities of this fish are shipped to distant northern markets. For baking, a fine large one has few equals. Bright red color in fishes has often a peculiar significance, which will be spoken of later.

Though not exactly a snapper, the excellent table-fish known as the Yellow Tail (Color Plate, page 181) belongs to the snapper family. It is somewhat more elongated than the true snappers, with lines more graceful, and its tail-fin is more deeply forked. One sees immediately that it is a freer, swifter swimmer, navigating wider stretches of more open water.

WHY SWIFT SWIMMING FISH HAVE FORKED TAILS

Most marine animals which swim, especially swiftly and continuously, have a forked tail-fin. This shape of tail avoids the space immediately behind the axis of the body where the stream-lines following the sides (of a moving fish) converge. A rounded or pointed tail which would occupy such area would be a drag.

Whales and Porpoises, though they move the tail up and down instead of from side to side, have a forked tail-fin, only it lies in a horizontal instead of a vertical plane. The wide ranging members of the mackerel family and other more or less related marine fishes have a forked tail-fin set on a firm, narrow base; and the freest swimming sharks (Mackerel sharks and the Man-eater) have acquired a tail of the same shape, though the ordinary shark tail is weak and unsymmetrical.

Fresh-water minnows almost invariably have a forked tail-fin, waters which they have to traverse being considerable in relation to the small size of the fishes themselves.

In the blues and greens of the waters through which it swims, the Yellow Tail's bright yellow tail probably makes a shining mark, though its colors otherwise are well calculated to give it a low visibility. Are we to conclude from this that there are no larger fishes which prey on it? No; there pretty surely are such fishes, though it may well be so swift as to escape many.

DEEP SWIMMING FISH ARE OFTEN RED IN COLOR

As regards concealment, having a yellow tail must be a disadvantage to it, and is a character which would doubtless have been lost in the keen competition of the tropical waters where it lives, were there not, on the other hand, some compensating advantage. It may be a badge of identification, useful to a school in keeping together.

It has been previously mentioned that the Red Snapper comes from deeper water than other common snappers. There is a tendency for fishes which swim deep down under the blue or green sea and yet within the range of surface light penetration to be red in color. A great many are not, to be sure, but a larger proportion are red here than elsewhere, frequently a clear bright striking red all over.

It seems almost a pity that the light in which they live is so green that the color, red, must appear an intangible neutral gray! Perhaps it gives them a useful inconspicuousness down there, or perhaps it absorbs a maximum amount of the dim, strongly blue-green sunlight, which is in some way beneficial.

One of the commonest species of the surface reefs, the Squirrel Fish (Color Plate, page 175), has a regular, bright, "deep-water" red color. But the mystery of how it comes to such a color is easily explained, for it has similar relatives living deeper down. Evidently the Squirrel Fish has recently come up in the fish world, and its big eyes indicate that it has not yet adjusted itself to the bright light of the surface sun, but is more or less nocturnal.

The Gulf Stream runs so close to the coast of Florida that, when the wind is right, quantities of the drifting yellow gulf-weed it carries are washed ashore and into the bays. A variety of fishes hide in and about this weed.

One of the commonest and perhaps the most interesting, namely, the Mouse Fish, spends its entire life in the drifting sargassum. Colored in wonderful mimicry of this habitat, its shape also, grotesquely irregular, covered with leaf-like processes or flakes, heightens the resemblance, so as to make it well nigh invisible. This protection against larger fish which might disturb it probably also serves the pur-

pose of camouflage to enable it to approach and capture smaller fish, crabs, and shrimps.

THE PORTUGUESE MAN-OF-WAR HAS A
FAITHFUL COMPANION FISH

The Mouse Fish, for its size, has a large mouth and appetite in proportion. Many other species hide in the weed when young and, as a rule, have colors to match at that time of life, though later they may be quite different.

The rainbow-tinted pink, blue, or purple bubble-like floats of the Portuguese Man-of-war (Color Plate, page 178) drift at the surface over all tropical oceans and are sometimes washed in close to the shore in numbers. With them comes an interesting companion, a very small and beautiful colored fish called *Nomeus*, which never strays far from the tentacles which stream below the Man-of-war. The *Nomeus* decoys little fishes into his protector's trailing tentacles which sting and stun them and thus provide food for both.

When traveling by steamer along the Florida coast the writer has watched for *Nomeus*, and from where he stood on deck has seen one and sometimes more individuals lying suspended in the clear water, their blackish ventral fins conspicuously spread, always within a short distance of a Man-of-war, floating above.

WHEN THE FLYING-FISHES PLAY

Comparatively few kinds of fishes are abundant "off-sounding," away from the influence of the shore-line, and these may be divided rather sharply into the hunters and the hunted. Mouse Fish and *Nomeus*, belonging to the latter class—the one hides, the other lives under the protection of a powerful companion.

Flying-fishes, which are abundant, have an even more interesting method of escaping their enemies, leaping above the surface and, with favorable wind conditions, shooting through the air for perhaps as much as an eighth of a mile, supported by their long, stiff breast-fins, widely spread at right angles to the body. When there is a whole-sail breeze blowing, they seem to fly also for sport.

A flock of little Flying-fishes no bigger than herring, all in the air at once, gleaming blue and white silver in the sun, is

one of the most beautiful sights of a tropical sea. The very thought of it takes one back to the broad blue expanse of trade-wind ocean, warm decks lurching under foot, spray singing through the shrouds, squawking tropic birds and bellying square-sails which swing against a background of fleecy cloud and sky.

In spite of their agility, Flying-fishes form the chief food of the little schools of Oceanic Bonitos, and of the Dolphins, swiftest, most graceful, and most highly colored of marine fishes, which prowl over the high seas.

THE PRIMEVAL SHARK IS STILL WITH US

Ages before modern fishes, of which we now find such countless variety in tropical seas, had been evolved in the slow process of evolution, there were sharks which differed comparatively little from those of the present day. Intermediate forms have become antiquated and dropped out, but the primeval shark (Color Plate, page 180) is still with us. Especially in the tropics they occur in great abundance.

Prowling singly along the edges of the reefs, over the shallow flats, or through off-shore stretches of open water, they hunt largely by sense of smell, and congregate in numbers wherever food is abundant.

When a whale is being cut up at sea it is astonishing how quickly the slender offshore Blue Sharks gather to the feast; it would almost seem from nowhere.

By far the most abundant sharks numerically are the ground sharks (*Carcharhinus*). There is probably no tropical or temperate coast-line where one or more species of this genus do not enter the bays and inshore water at the proper season to give birth to their young.

SHARKS PROPAGATE UNLIKE MOST
OTHER FISHES

Though relics of a bygone age, as far as bodily structure is concerned, sharks, of all fishes, have the most highly developed reproductive system. Some lay a few large eggs, each one protected by a horny shell, but for the most part the egg stage is passed through within the body of the parent fish, and the young are born well grown and able to fend for themselves.



THE SQUIRREL FISH OR SOLDATO (*Holocentrus ascensionis*)

These bright hued habitants of the tropical seas are to be found in the waters surrounding the Bermudas, Florida, the West Indies, St. Helena and Ascension Island. They reach a length of two feet, and are considered a good food fish.



THE PORK FISH (*Anisotremus virginicus*)

This important food fish, found from Florida to Brazil, reaches a length of fifteen inches, and lives in large numbers about coral heads and reefs. It is easily trapped by market fishermen.



FOUR RESPLENDENT TYPES OF ANGEL-FISH

The Blue Angel-Fish (*Angelichthys isabelita*), shown at the lower left, feeds chiefly on crustaceans, and lives among the coral reefs of the Florida Keys and the Bermudas. The Black Angel-Fish (*Pomacanthus arcuatus*), shown at the upper right, is found from New Jersey, through the waters of the West Indies and as far south as Bahia, Brazil. It is one of the most beautiful of reef dwellers. The French Angel-Fish (*Pomacanthus paru*), shown at the lower right, is found from Florida to Bahia, and reaches a foot or more in length, but is not considered a good food fish. The Rock Beauty (*Holacanthus tricolor*), upper figure, is rarely found in Florida waters, but swims as far south as Bahia. It lives in the deeper parts of coral reefs, and is most difficult to trap.

THE SPADE FISH IS ALSO KNOWN AS THE WHITE ANGEL (*Chaetodipterus faber*)

This excellent food fish, which attains a length of from two to three feet, is caught by hook from Cape Cod to Rio de Janeiro. It is especially abundant on our South Atlantic Coast.



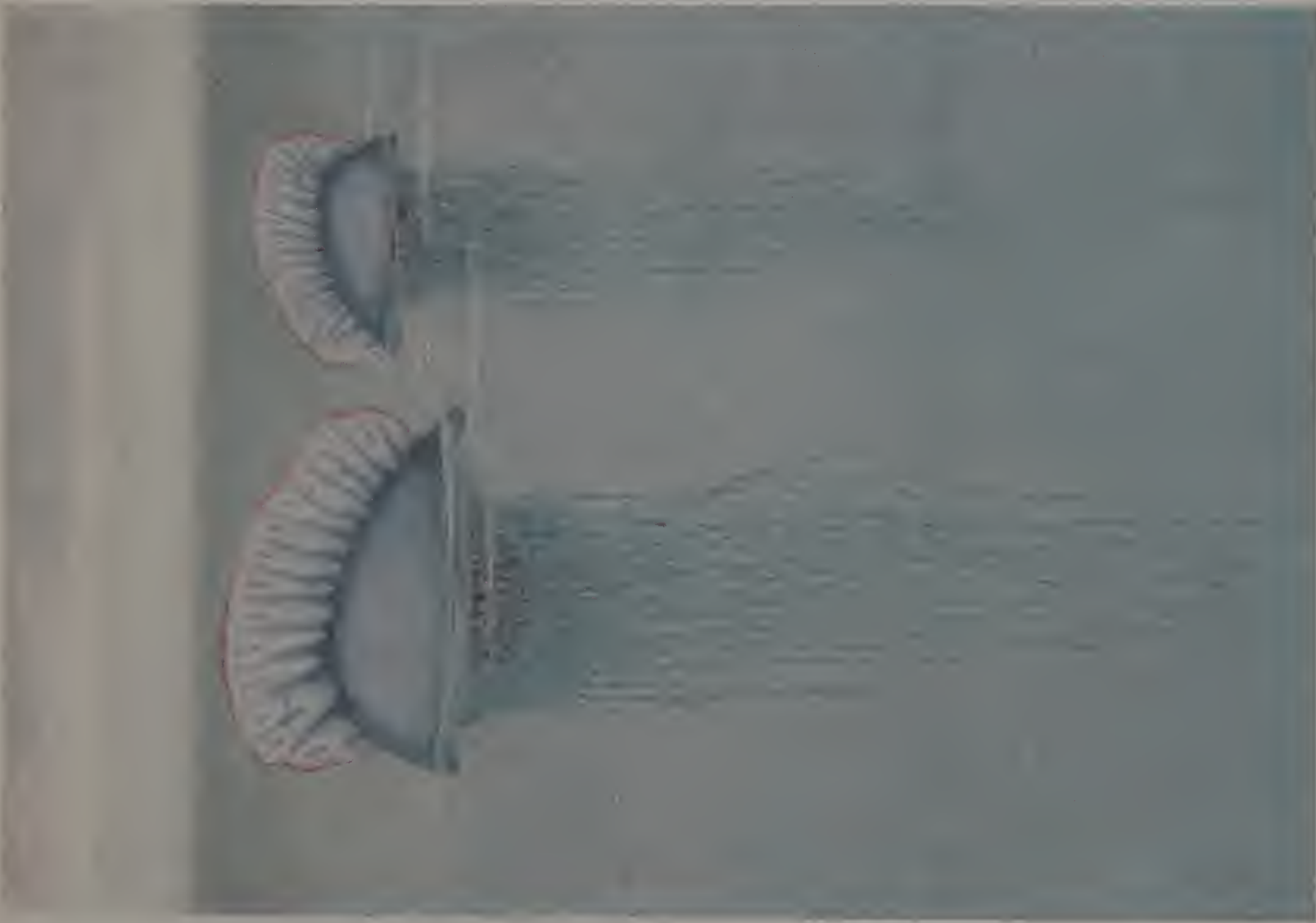
THE FOUR-EYED FISH (*Chaetodon capistratus*) AND BUTTERFLY FISH (*Chaetodon ocellatus*)

The Four-Eyed Fish, shown in the left top corner, is a parasite hunter. It even goes into the mouths of larger fishes which remain perfectly still while the little fellow hunts for its prey. The Butterfly Fish is one of the most conspicuous of reef dwellers. Both species are found in Florida and West Indian waters.



THE GREEN MORAY (*Lycodontis funebris*)

This largest of eels, which sometimes reaches a length of eleven feet, is an excellent food fish. It is found in tropical seas from Bermuda and the Florida Keys to Rio de Janeiro, and from the Gulf of California to Panama and in the East Indies.



THE PORTUGUESE MAN-OF-WAR (*Physalia arethusa*)

Floating on the surface with the tide and currents, in search of food, this curious sea creature trails its tentacles behind it for forty feet. The tiny fishes upon which it preys become helpless after coming in contact with the stinging cells of the tentacles. The Portuguese Man-of-war is found in tropical seas, but sometimes strays as far north as Cape Cod. Among the tentacles of this creature the little Portuguese Man-of-war Fish hides from its enemies.



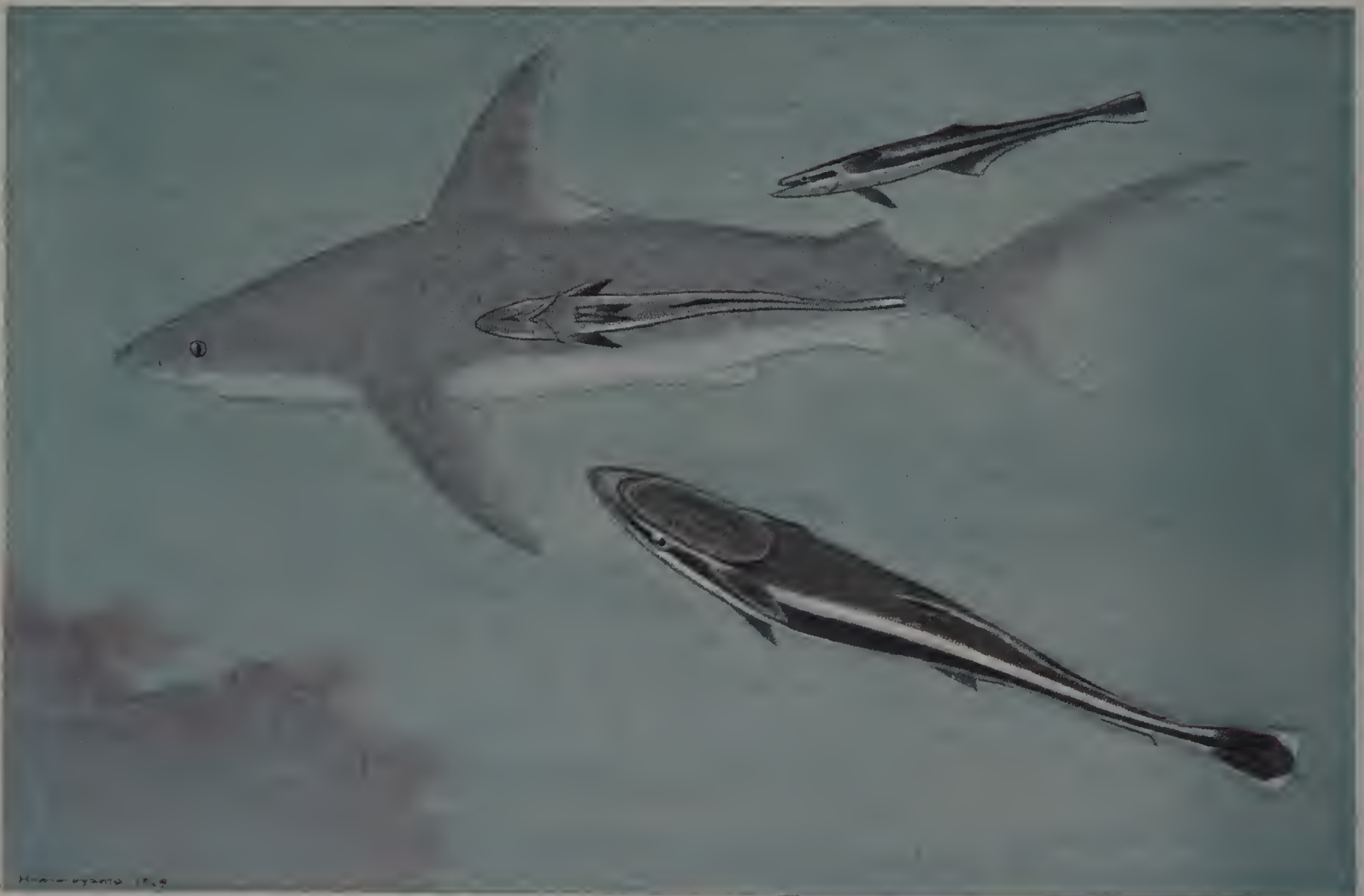
THE SEA HORSE (*Hippocampus*)

This is the only fish which possesses a prehensile tail. With its curious appendage, it holds to seaweed while feeding on small crustaceans. The female deposits her eggs in an external abdominal pouch of the male, where they are hatched. The Sea Horse is found in all warm seas, including the Caribbean, the Black Sea, and the waters south of Japan. One species is found from South Carolina to Cape Cod.



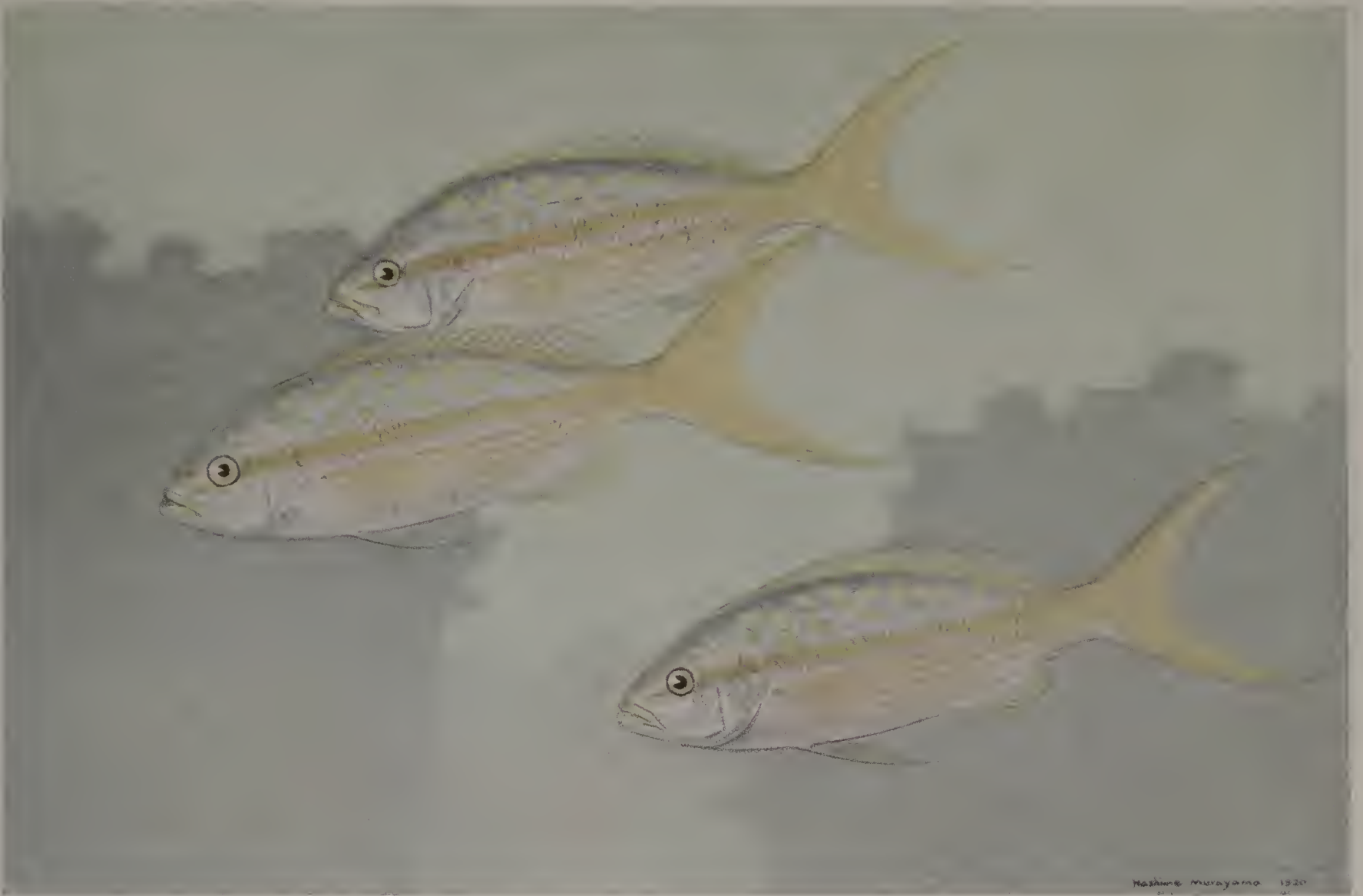
THE ROCK HIND (*Epinephelus adscensionis*)

This spotted beauty inhabits tropical American waters from Bermuda to Brazil, and is often encountered on the east coast of Florida. It lives in rocky places, and is highly esteemed as a food fish. It reaches two feet in length.



THE SHARK SUCKER (*Echeneis naucrates*)

This curious inhabitant of warm seas attaches itself by means of a suction disk to sharks, turtles, and other large denizens of the deep. On the African coast it is used by natives to capture turtles. The fisherman attaches a cord to the shark sucker's tail, and allows it to swim among the turtles. When it has attached itself to one, the turtle is quickly hauled in.



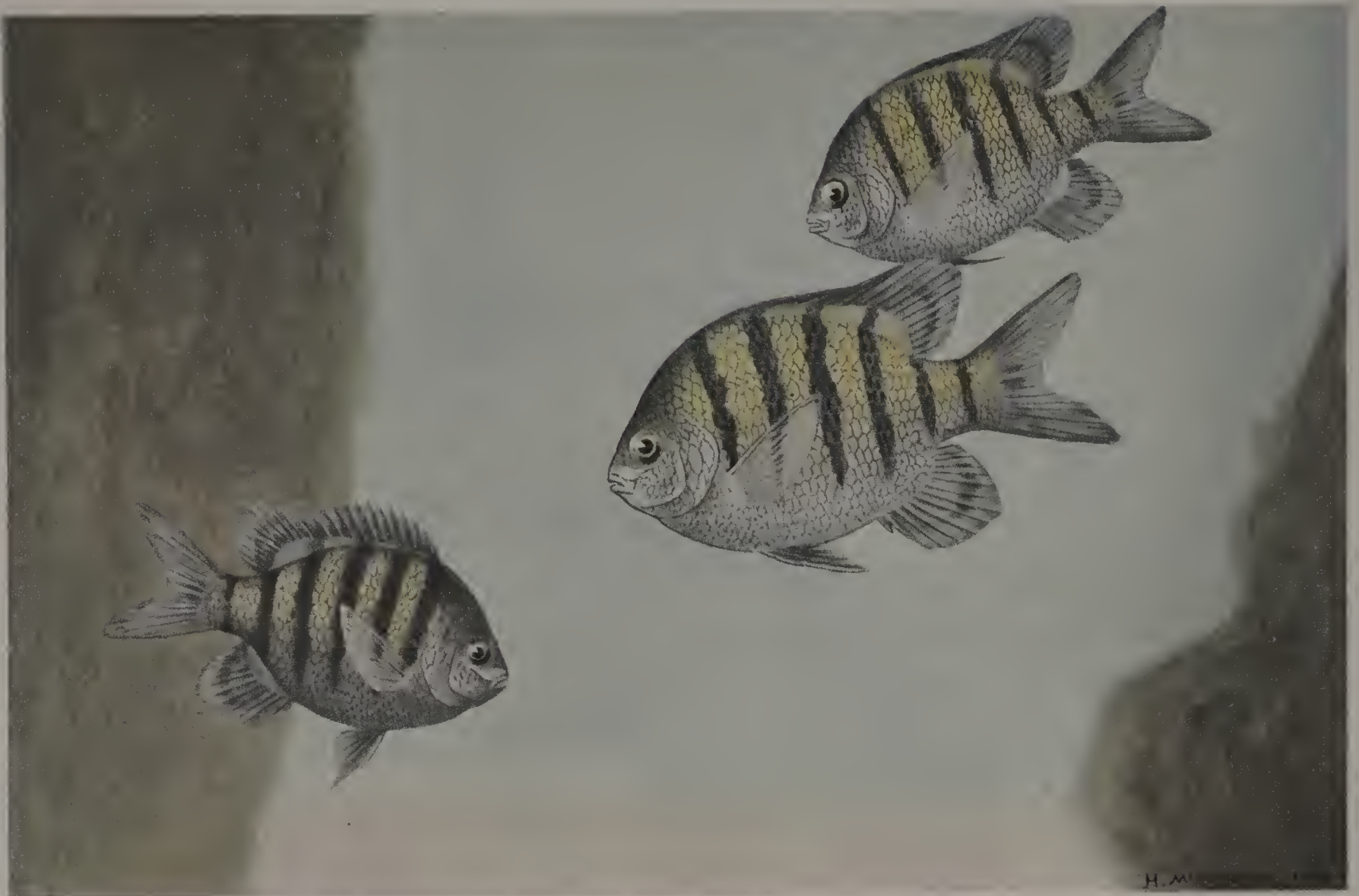
THE YELLOW TAIL (*Ocyurus chrysurus*)

This excellent food fish, reaching a length of three feet, is one of the gamiest of the snapper tribe. It is found in the waters off the coast of Bermuda, Florida, and the West Indies, as far south as Brazil.



THE BLUE STRIPED GRUNT (*Haemulon sciurus*)

This food fish reaches a foot in length and lives about rocky shores from the Bermudas as far south as Brazil. It feeds on worms and crustaceans.



THE SERGEANT MAJOR OR COW PILOT (*Abudefduf saxatilis*)

As its name, *saxatilis*, implies, this inhabitant of tropical American waters lives among the rocks. It attains a length of six inches and is not used for food.



THE RAINBOW PARROT-FISH (*Pseudoscarus guacamaia*)

Weighing as much as sixty pounds, the Rainbow Parrot-fish is the largest of its family. The flesh is soft but of very good flavor. It is found from the Florida Keys to Rio de Janeiro, and lives on mollusks, worms, and several species of algae.

The Black-tip Shark (*Carcharhinus limbatus*) is a small species of ground shark, females of which are taken with young in the Bay of Florida in April. They are frequently hooked by tarpon fishermen, who erroneously call them "mackerel shark," and put up a spirited fight. They are usually between five and five and a half feet in length, and the young, about three to six in number, are two feet long, or a little less, when born.

We have data concerning another ground shark, *Carcharhinus milberti*, the Brown Shark, which gives birth to its young in Great South Bay, New York, in midsummer. The mother sharks are a little larger—six or seven feet—the young, however, of about the same size, but more of them, eight to eleven having been recorded for this species. Some kinds of sharks which grow much larger have a proportionately larger number of young.

While evolution has been molding other more modern fishes into a great variety of forms to fit every niche in the infinitely varied but unchanging environment of tropical seas, the shark has always been much as we find him today.

A FISH THAT UTILIZES A SHARK AS A TAXI

It is not surprising, therefore, that there is a fish which owes its very remarkable structure and habits to the presence of sharks. This is the slender Shark Sucker (Color Plate, page 180), which has the anterior portion of its body horizontally flattened, and a remarkable oval structure, with movable slats like those of a blind, on the top of its head. With this apparatus it attaches itself firmly at will to the shark's broad side and thus as a "dead-head" passenger, is transported through long stretches of ocean without any effort on its own part.

The Shark Sucker is boldly and very beautifully striped with black and white, but can change its color almost instantly to a dull, uniform gray matching the side of the shark to which it is clinging. It sometimes attaches itself also to other large fishes, such as the Tarpon, or to turtles.

A related species, the true Remora, is found clinging to those sharks which swim through the high seas far from

shore. A third is found clinging about the gills of Spearfish or Marlin Swordfish, as they are called by California anglers. A fourth, with very large and strong sucking disk, has been found attached to whales.

All of these may, loosely speaking, be called Remoras. They are sometimes erroneously spoken of as "Pilot-fish," for the Pilot-fish is an entirely different small species related to the Amber Jack, which swims in front of or beside sea-going sharks and is vertically banded with black.

Among the fishes of the world the Remoras occupy the position of a genus with unknown ancestry. There is nothing else like them, and to what manner of fishes they may be related is one of the mysteries of old ocean.

Fish life of the shallow pools so often found along a rocky shore at low tide will repay careful study. Such a pool may be a few yards long, with a very irregular outline, full of nooks and crannies, and a few square feet of sand covering its lowest point.

Here the young of several types of fishes act out in miniature the drama which their elders are playing on the reef. Only the villains of the play, the larger predaceous fishes, are absent, at least for the present, until the returning flood inundates the isolated pool to make it once more a part of the big salt water, and we retreat up the beach.

The stage setting is extremely simple: the jagged blackish bottom of the pool, small area of gray-white sand, a little patch of brownish seaweed in one place, either growing there or drifted in at the last high water. From a distance half a dozen small fishes are visible, swimming actively about.

Nearer view shows them to consist of two or three Sergeant Majors, instantly recognized by the black and yellow uniform in vertical stripes; a couple of Beau Gregorys, with bright blue heads and yellow tails separated by a slanting line of demarcation, and a young Wrasse striped lengthwise with black on a pale ground.

THE WRASSE CHANGES ITS COLOR INSTANTLY

If one attempt to catch a fish of either of the former species, it displays great



THE AQUARIUM, MIAMI BEACH, FLORIDA

Located on the very Gulf Stream itself, the exhibit of fishes of the warm sea to be seen within the Miami Aquarium are unexcelled in variety and beauty of color anywhere in the world. The Aquarium gardens contain numerous varieties of beautiful palms and subtropical flora.

alertness and agility, dodging about the many projections and irregularities of rock. But now we have the Wrasse cornered and believe we have it in an instant, when suddenly it has disappeared.

Surely it did not dodge past and make good its escape in that way. Where can it be? Two or three minutes of careful scrutiny are rewarded. There it is, motionless, squeezed into a crevice of the side of the pool just large enough to hold it.

Swimming actively about, it was scarcely less conspicuous than the Sergeant Majors, but it has now, furthermore, changed color, so as to have a very low visibility in its sheltered nook. Here we have an illustration in detail of how various theoretical types of coloring work out. While swimming about with them the Wrasse had a *conspicuous immunity* pattern like the Sergeant Majors; now, in the twinkling of an eye, it is a concealingly colored fish.

THE SAND FLOUNDER DEFIES DETECTION

We have been speaking of fishes which no one will hesitate to admit are concealingly colored; but, lying in plain view on

the sand, there is a little pale-colored Sand Flounder so exceedingly inconspicuous that it is unlikely that we shall see it unless the water is drawn out of the pool and its inhabitants raked into our collecting bottles.

NOISY FISHES OF THE DEEP

One thinks of fishes as leading a life of perpetual silence down there under the waters. This generalization is not in all cases true, however. Lying anchored in a small boat at night in Florida waters, one may sometimes hear a school of Sea-drum go swimming by below. "Wop, wop, wop," they seem to say. Then there is the little Trumpet-fish, so called, whose identity is open to question, technically speaking, that will at times lurk under the boat and intrigue you with its elfin tooting.

Many species utter croaking or grunting sounds when caught, the various species of Grunts owing their name to this habit.

Grunts are fish somewhat resembling snappers in appearance and to a certain extent in habit, but smaller and less vig-



Photograph from Col. William H. Edwards

AN ARMFULL OF AMBERJACK

The Amber fish is a determined fighter, excellent as to food value and in the Aquarium tank lives well and is active. Specimens have been taken weighing up to 100 pounds.

orous. They are variously and artistically colored in grays, blues, and yellows. The Blue-striped or Yellow Grunt (Color Plate, page 181) is yellow, with blue length-wise stripes. The Common Grunt has many narrow stripes of deep, clear blue on the head, the scales of the shoulder region enlarged and conspicuous, bronze

in color, with grayish borders. The French Grunt is light bluish gray, with broad, undulating, irregular stripes of yellow; and there are many other varieties.

Grunts have bright red or orange color at the base of the jaws and inside the large mouth. The color is not visible when the mouth is closed.





Photograph by James A. Allison, Miami Aquarium

TWENTY-TWO FEET ACROSS FROM TIP TO TIP

A remarkable photograph of the giant Devil-fish, with the tips of its wing-like fins above water, actually towing a 25-foot motor-boat at an estimated speed of 10 miles an hour. There were three harpoons in the broad back of the fish at this stage. The sea monster had towed the heavy launch many miles, but was still going strong when this picture was made.

Devil-Fishing in the Gulf Stream

By JOHN OLIVER LA GORCE
Associate Editor National Geographic Magazine

WHAT the rolling prairie of the Far West was to the buffalo in the olden days, when it roamed in countless thousands to and fro in search of new pastures and salt, the ever-rolling Gulf Stream—that mighty, warm river which parallels the east coast of Florida—is to the fish legions of our semi-tropical seas.

How many fishermen realize that there are found in the Atlantic Ocean offshore between Miami and Key West nearly 600 varieties of fish—an amazing total which constitutes one-fifth of the entire fauna of the American Continent north of Panama!

UNRELATED MONSTERS OF THE DEEP

When one starts in to tell of the amazing variety of undersea life along the Florida east coast, it is difficult to decide where to begin and end, for it is an inexhaustible subject. Such being the case, I will not attempt a survey of it now, but will confine myself to the experience of our party in hunting and capturing a Devil-fish, said to be the largest specimen taken in American waters in twenty years.

In the general mind the Devil-fish and the Octopus are frequently confused, whereas they belong to entirely different fish families, and the only physical resemblance between these two gentry lies in the fact that they both live in the same waters. The Devil-fish, or *Manta birostris* of science, belongs to the giant ray family—a huge batlike creature which uses its body fins as a bird does its wings in flying, with a waving, undulating motion, which propels it along beneath the water at remarkable speed.

Aside from its immense wing-spread, the outstanding feature of the Devil-fish, and the one from which it derives its satanic name, are the lobes, or, as they are sometimes termed, cephalic fins, which extend outward and upward from each side of its flat head like curling horns.

In the adult fish the head fins are from three to four feet in length and about six

inches wide. Nature has fashioned them of a leathery muscle tissue which spells strength in every ounce.

When the giant ray dashes into a school of fish, these head fins are of great assistance in obtaining food, for, like the arms of a boxer, they are in constant motion, whirling about and sweeping its living prey into the yard-wide mouth with almost lightning speed, as it hurls its great body about in its natural element.

The remarkable strength and twisting movements of the so-called horns are responsible for many of the allegations lodged against this fish as a menace to mankind, whereas, unless attacked and in panic, the huge sea-bat hurts no one.

As a matter of fact, however, there are a number of authentic reports of the Devil-fish's running foul of a ship's anchor chain. True to instinct, it clasps the chain tight by wrapping its tenacula horns or feelers about it, applies its tremendous strength, lifts the heavy anchor as if it were a feather, and starts to sea with the anchor, chain, and ship, to the amazement and terror of the crew, who cannot believe their very eyes, as their vessel moves onward at a fast pace without a sail set or an engine's turning over, when, to all appearances, a moment before their vessel was moored to the ocean floor.

THE OLD MAN OF THE SEA

The Octopus (Color Plate, page 156), on the other hand, although sometimes termed "Devil-fish," is of another family entirely, an invertebrate, known to science as the typical genus of Cephalopods, or, in plain words, the highest class of mollusca, in which squids, cuttle-fish, and octopi are grouped. In Pacific waters the Giant Octopus, technically known as *Octopus punctatus*, grows to an immense size; indeed, captured specimens have measured a radial spread of 20 to 30 feet.

In appearance the Octopus is most repulsive, having a large, ugly head, a fierce-



Photograph by Charles H. Thompson

AMBER JACK, A FINNY FIGHTER

Bahama natives call the Amber Jack the "family feeder" for it grows so large in the warm seas one will furnish food for a household.

looking mouth, armed with a pair of powerful horny jaws, shaped much like a parrot's beak, atopped with two diabolical eyes set close together, which are positively capable of sending forth a demoniac glare when the creature is angered. The grotesque head is mounted on a somewhat oval body, from which radiate eight arms, usually united at the body base by a membrane. The arms or tentacles are provided with rows of suckers, with which it clasps and clings to its prey with uncanny strength and quickness.

As a rule, it will not give battle to man unless angered or injured, but when challenged will fight to the last, doing its best to pull the object of its wrath beneath the surface of the waters.

THE START FOR THE HUNTING GROUNDS

From the Florida reef the run across the Gulf Stream to the nearest islands of the Bahamas is a matter of about 50 miles. We started from Miami Beach at noon, guests of James A. Allison, on board his sea-going motor yacht *L'Apache*, with a 25-foot motor-driven fishing boat bobbing along behind in tow.

In the party of fishermen were Mr. Allison, Captain Charles H. Thompson, of Miami, the internationally known authority on the fish of the east coast of Florida; Commodore Charles W. Kotcher, A. G. Batchelder, and the writer, together with Captain Peterson and the crew of the *L'Apache*.

Assisted by the northeastward pressure of the ever-moving Gulf Stream, we made splendid progress, and that evening cast anchor behind Bimini, a tiny isle which rests like a jeweled feather on a summer sea, the westernmost outrider of the Lower Bahama group. Bimini is a quaint little coral dot a few miles long and a quarter of a mile wide, quite covered with clusters of coconut palms and tropical plants, its tallest headland rising but a few feet above the surface of the old Atlantic—an out-of-the-world spot then peopled by a few score of Bahama negroes, who eke out a precarious existence by fishing, gathering shells, and, in a small way, cultivating sisal, the fibrous plant from which hemp rope is made.

Approaching the island, the ocean bottom for miles offshore is carpeted with snow-white sand, and so clear is the

water that there is no difficulty in studying the vast marine gardens 30 to 50 feet below the surface.

Due to the white sand beneath the sea and the glorious blue of the sky, with the ever-changing cloud effects overhead, the bewildering gradations of color to be seen in these waters challenge description and fill the heart of the artist with despair, although he paint with the inspired brush of genius.

OVERSEAS CEREMONY

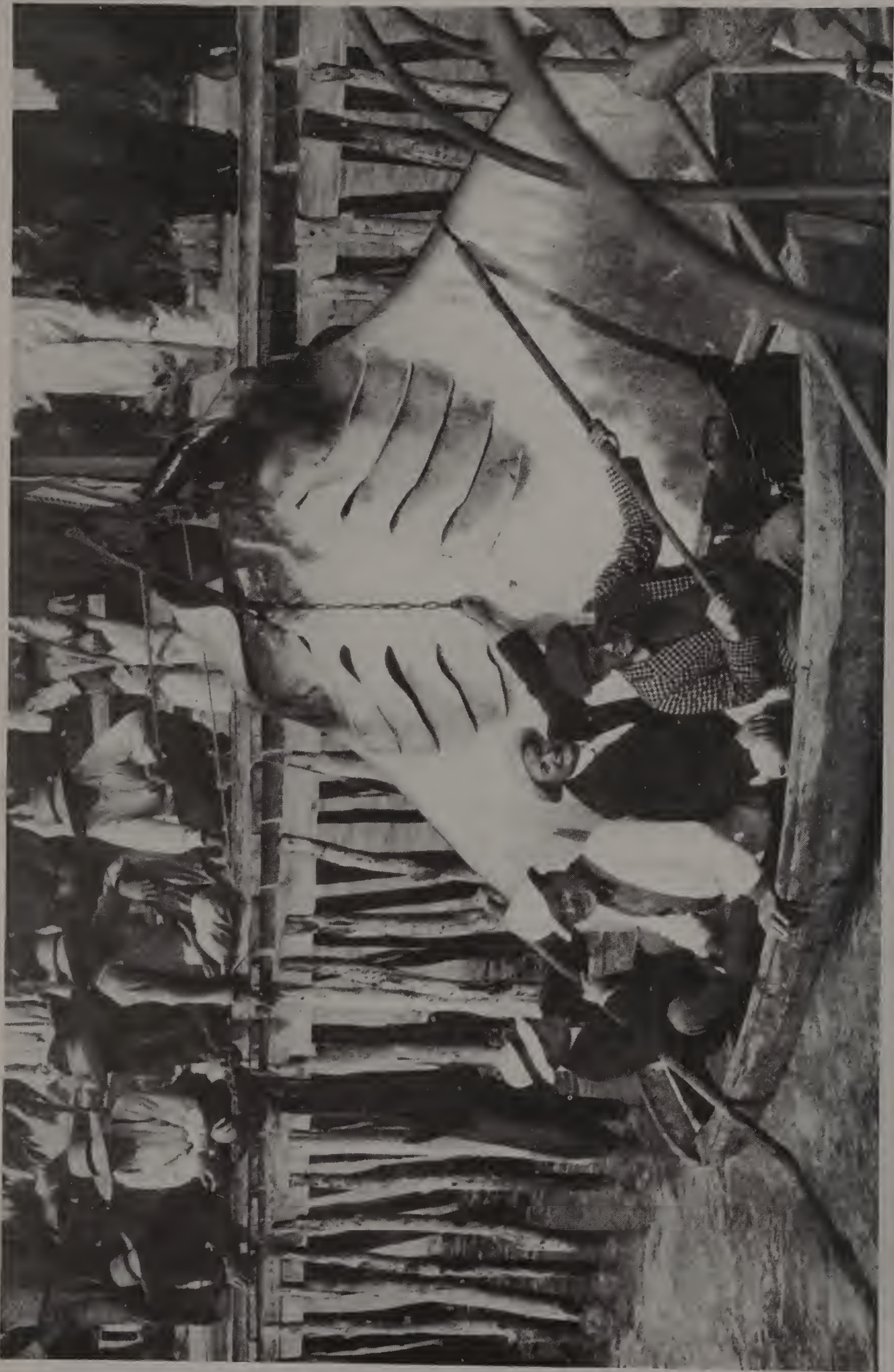
The Bahamas being colonies of Great Britain, of course her authority extends even to this little dot. Therefore, Bimini boasts a port officer—an English gentleman, who also serves as the Crown Commissioner, Police Magistrate, Customs Collector, and Consular Official for examination of passports, as well as being physician and school teacher to the island's inhabitants. In short, he is the Twentieth Century Pooh Bah, who, with much courtesy and dignity, meets the foreign craft when it drops anchor upon arrival, inspects all qualifying documents, then sadly waves adieu from the beach when the visitor sails away.

Up to the day of our arrival, there hadn't been a piece of fresh beef or a bit of butter on the table of the Crown's Representative for nine months, much less that of a single one of Bimini's humbler inhabitants, for the isle is more than a hundred miles from Nassau, and even the mail-boat was conspicuous by its absence during the period of the European war, when enemy submarines were in South Atlantic waters.

THE SEA SUPPLIES THE LARDER

So it is that the sea furnishes food for the Biminities, supplemented by a few vegetables, flour, and salt meats, when they can get supplies from Nassau. Conch, the marine animal which inhabits the beautiful spiral shell, so fashionable as a parlor ornament a generation ago, is the chief article of food, and the natives consume thousands of them each year; indeed, it can be considered their main article of food.

After we had received and returned the official call of the Crown's Representative, we had visitations alongside from several shore boats, manned by



Photograph by Carl G. Fisher

THE GIANT FISH AND ITS CAPTORS

Note the curling, horn-like head fins of the Devil-fish, with which by a circular motion it sweeps live food into its mouth by the bushel when it dashes into a school of fish. The series of vents on its belly, which look like the hood of a well-known automobile, are in reality the breathing apparatus, or gills. The dark object hanging from the wharf on the left is a Herring-Hog, a species of porpoise, about eight feet in length and weighing about four hundred pounds.

dusky-hued merchants, each tradesman clad, on an average, in one and a half garments, who, with a happy grin and a hungry look, offered for sale varieties of sponges, brilliantly colored conch shells, sea-beans, and tortoise shell, the last-named article being obtained from the Hawksbill Turtle, which is quite plentiful in these waters.

THE LURE OF THE TROPICAL NIGHT

It was like pulling teeth to go below and leave the wondrous beauty of the tropical night, with the soft, cool touch of the ever-blowing trade wind, the shadowy grace of the giant coconut palms swaying and whispering on the near-by beach in the moonlight, while the surf, grounding upon the coral strand on the outer side of the isle, lulled us with its crooning obligato.

But the wiser heads spoke of the need of a good night's rest to prepare for the battle royal which we hoped was in the offing, and so we regretfully went below and to dreamland instead of having a try at the Tarpon which we could hear jumping and rolling on the surface, like playful puppies, only a few hundred yards astern.

At sunrise the next morning all hands were up and ready for the fray. The chef soon had a hot breakfast served, after which we piled aboard our motor-driven fishing boat, upon which our rods, lines, and harpoons had been made ready the night before.

Making a course out through the island channel to sea, all excepting the steersman hung over the side to enjoy the amazing sights below in the deep ocean pools. One of us would excitedly point to a squad of six or eight big Tarpon lazily wallowing about far below—lords of their element, unafraid; therefore ready to give battle to anything except, perhaps, a Tiger Shark.

Another startled angler would call from the other side that a 10-foot Hammer-head or a Nurse Shark was rolling an eye at him from the ocean floor, while still another inland fisherman wanted to jump down among a school, numbering possibly ten thousand large and small Mangrove Snappers, busily parading up and down a long stretch of coral shelf on the bottom, which afforded them instant hiding places in case of the sudden appearance of hungry enemies.

Passing out over the entrance bar, we set a course for the open sea, and soon all hands were scanning the pulsing bosom of the Gulf Stream for big game, like the crew of a submarine destroyer peeling their eyes for a periscope in the danger zone.

Strange as it may seem, the noise of a motor boat does not appear to make the fish of the warm seas apprehend danger. If they are attracted by the bait or are not disturbed by the approach of a natural enemy below water, one can not only get very close to them, but has little difficulty in keeping the big fish in sight, once they are located and something of their habits known.

After a while Captain Thompson called our attention in his quiet way to a long, dark shadow not far below the surface a couple of boat-lengths away, and the boat was turned toward the first sign of our quarry, which he said was a "Herring-Hog," a species of porpoise. It proved to be an adult about eight feet long, weighing around four hundred pounds, and as this species destroys great quantities of foodfish, we went for it.

Reaching the proper position to strike, a hand harpoon was thrown, found its mark, and away the Herring-Hog went at a fast clip, the line fairly smoking from the barrel. And soon we were being towed along—a strange sensation to the novice. One of the less experienced fishermen of the party was given the harpoon line with instructions to bring the big fellow alongside forthwith, and further ordered above all to "keep his head up," the rest of us sitting back to enjoy his attempts to obey.

THE REAL BUSINESS OF THE DAY

About twenty minutes after the strike and while yet the Herring-Hog was demonstrating no signs of tiring, although this could not be said of the perspiring fisherman into whose care he had been given, a considerable disturbance was observed on the surface of the water about a quarter of a mile away, and it was judged to be either a leopard shark at kill or a battle royal between two big denizens of the deep. Anything can be expected in these waters!

It was our business, however, to have ring-side seats at this battle, whatever it was. So all hands took hold of the Her



Photograph by John Oliver La Gorce

GETTING THE FISH ASHORE AFTER IT HAD BEEN PARTIALLY DISMEMBERED

It took a long while and much effort to get the Devil-fish ashore at Bimini so that the hide and cartilage structure could be preserved for mounting.

ring-Hog line and, reversing the engine, which was not very sportsmanlike, but decidedly effective in checking it, we brought him alongside without further loss of time; then turned our attention to the new mystery now close at hand.

We were all excited at the thought of getting a harpoon into a big Leopard Shark, which will fight any and everything that swims, and, according to some deep-sea fishermen, is really the only member of the shark family of whom man need be afraid while in the water.

But the reader can imagine how our interest was increased when all at once Captain Thompson, who, having uncanny eyesight plus long experience with sub-sea life, suddenly exclaimed: "Stand by, men; it's the biggest Devil-fish I have ever seen!"

LIKE A HUGE FLAPPING BIRD

As we drew near it seemed to me that the entire bottom of the ocean in that area was suddenly dark and slowly moving off, and I discerned in the translucent depths a gigantic shadow which had the appearance of a huge bird flapping its wings and swinging its long, thin tail from side to side, as it flew slowly along.

While we were coming up within striking radius of the fish, which was evidently devouring something it had killed and was paying no attention to anything else, our harpoon lines, used in dispatching the Herring-Hog, had been straightened out and put in readiness for the combat which was to come.

As soon as we came near enough, Captain Thompson let fly with his heaviest harpoon, and then, as the little boy said when he dropped the cat into the pail of stewed tomatoes, "the fun began."

I am sure that none of us was ready for what followed. The Devil-fish rose as though hurled upward by a submarine explosion. One of its great bat-like fins broke above the surface, sending gallons of water over us and splintering the harpoon pole against the boat's side as if it had been a match stem; then its 10-foot pectoral wing struck the water with a terrific impact, making a noise which could have been heard several miles away.

For a moment the monster seemed bewildered, and that lost moment cost him dear, for it enabled us to throw another

harpoon, which struck deep into its body near the spine. Away it started to sea, taking our harpoon line with it, at a pace which made us apprehensive as to its length, although a moment before, we thought there was a wide margin for safety. Gradually all hands put their weight against the line, and as the boat was by this time moving properly on an even keel, we took a wrap around a bow cleat and started seaward—giant fish, boat, and crew!

Every once in a while the Devil-fish would hurl itself several feet out of the water, and its huge body would come down with a crash like the explosion of a 42-centimeter shell! Moreover, each time it broke the surface it looked larger than before. Now and then it would sound for deep water in an effort to shake us off, and several times it went down so far that Thompson stood by with a hatchet to cut the lines at the last moment, in the event the bow should be drawn completely under water, which came perilously near happening more than once.

All of a sudden the lines slackened, and we frantically hauled in as the monster turned and dashed toward the boat, coming up almost, but not quite, under our craft, its gigantic bulk lifting one side of the heavy launch well out of water and giving us a pretty stiff scare.

THE BEGINNING OF THE END

With his usual skill and presence of mind, however, Captain Thompson let drive another harpoon he had at hand, which found lodgment in the Devil-fish's head, and away it dashed again. With two harpoon lines, one in each side of the body, we were actually able to drive the monster as one would a runaway horse, swerving it toward the distant shore of Bimini and into more shallow water by the process of pulling first on one line and then on the other, which course was a little too much for the fish to resist. Meanwhile time was flying apace.

By this time the Devil-fish had towed us for about ten miles, and although it was losing much blood, it was still going strong; so our next experiment was to throw out and let drag our anchor in order that this maneuver might further impede its progress. But this expedient made little difference to the giant, for it continued to pull us along as if our heavy craft were but a birch canoe.

After an hour or so, however, during which the Devil-fish alternated between trying to pull the bow under water and suddenly turning and endeavoring to come up under us, the anchor began to take hold better, and our giant was becoming a little more amenable to reason, so that a number of times we were able to haul in slack, rearrange our lines, and eventually to approach within 20 or 30 feet, as it labored along with its great batlike fins, a little less powerful in stroke and somewhat slower, all of its body in plain sight, five or six feet below the surface of the water.

WEIGHED MORE THAN 3000 POUNDS

It was at this point that Mr. Allison secured the pictures, which we have every reason to believe are the first and only actual photographs of a giant Devil-fish alive in its natural element. These photographs, because of the refraction of light in the water, do not give a clear idea of this monster's enormousness, and make it hard to realize that our remarkable catch measured 22 feet across from the tip of one pectoral fin to the other and 17 feet 1 inch from the head to the end of the tail, and, moreover, weighed considerably more than 3,000 pounds.

Seeing that it was well-nigh impossible to give it a death blow, and that at any minute in its jockeying the fish might come up squarely under the boat and upset us despite all that we could do, and as sharks had been attracted by its struggle and loss of blood, we naturally did not relish the thought of any such experience.

VICTORY AFTER HOURS OF BATTLE

Luckily, about this time, a fast-sailing little island sponge boat approached us to see what the excitement was all about, and we managed to make the spongers understand that they must go back to the yacht and bring the rifles, which had, unfortunately, been forgotten in our hurry to get started in the early morning.

The native mariners were most willing to help, and made all haste possible; so, after another hour of skirmishing and ring generalship on both sides, the ship's motor-driven dory came tearing out with

an express rifle, and we were enabled to give the *coup de grâce*.

Until that moment not one of us realized that nearly five hours had elapsed since we first tackled this Jumbo of the deep, and none of us knew how tired we were, for in good truth we had been far too busy to give a thought to such small matters. Although this fish finally had four harpoons in its body and a dozen shots in its head and heart, it was by no means dead, and even then we had considerable difficulty in towing it into the harbor, miles away.

Naturally, the natives of Bimini were very much interested in the capture, for Devil-fish were seldom seen much less captured, and we experienced no difficulty in engaging the services of a score of them to help get the carcass ashore, having decided to remove the hide and bony structure for preservation and mounting.

NEARLY WRECKS THE WHARF

By bringing into play a heavy block and tackle borrowed from the islanders, which was used for lifting and weighing cargoes of sisal fiber, and after much breaking of ropes, to say nothing of the wharf structure's being in serious danger of collapse because of the great weight of the fish, we finally succeeded in getting most of its body out of water, so that it could be photographed and weighed by means of a large sisal scale. The utmost capacity of this scale was 3,000 pounds, and this is all which is claimed for the fish, although we judged it weighed 4,000, or possibly 5,000 pounds.

Through the courtesy of Carl G. Fisher who had run over from the Florida coast in a fast express cruiser to join us in the sport, but who arrived too late to take part in the actual capture, we were enabled to send back the necessary parts to a taxidermist at Miami for mounting, although it was a problem to know what to do with so enormous a thing after it was mounted, since not many rooms will take care of a fish measuring 22 feet across, and it was decided it would be presented to the splendid Aquarium at Miami Beach, of which Mr. Allison is president.

Salmon, America's Most Valuable Fish

By HUGH M. SMITH

Former United States Commissioner of Fisheries

THE answer to the question, What are the most important fishes in American waters? is likely to vary with the geographical distribution of the persons addressed.

The average citizen who lives within the sphere of influence of the sacred fish effigy hanging in the Massachusetts State-house will undoubtedly name the Cod and its allies that frequent the in-shore waters and the great submerged "banks" lying off the coasts of New England, and British maritime provinces, and Newfoundland.

From the Hudson to the St. Johns, a primary vote would probably favor the Shad and Herrings among river fishes, and the Bluefish and Squeteague among marine species.

Along the 1,700 miles of low-lying coast that extends from Key West to the Rio Grande, the fishermen and the fish-eating public can hardly conceive of anything more important in the way of food fish than the Mulletts and Snappers.

Throughout the Great Lakes the Whitefishes, Trouts, and Pike Perches are so abundant and support such extensive fisheries that they would undoubtedly be awarded front rank by millions of people in the States abutting on these waters.

EACH SECTION FOR ITS OWN FISH

In the vast region drained by the Mississippi and its tributaries, such homely species as the Catfishes and Buffalo-fishes attain their greatest development, and originally contributed more than any others to the income of the fishermen and the food supply of a score of States; but these natives have now been supplanted by an Asiatic alien which, having received a course of cultivation in Germany, came to our shores because of inducements held out by our government, and now, under the inaccurate name of German carp, has become the most important inhabitant of our interior waters.

Finally, practically every person on the Pacific seaboard will, without hesitation

or fear of contradiction, assign the foremost place among fishes to the salmons, which, entering every stream from Golden Gate to Bering Strait, constitute the most conspicuous element of the fish life.

The last estimate is the correct one, for the Pacific salmons are the most valuable fishes not only of the United States, but also of the entire western hemisphere, and, with the single exception of the sea herrings, are commercially the leading fishes of the world.

THE FIVE SPECIES OF PACIFIC SALMONS

The Pacific salmons constitute a distinct group, closely resembling the Atlantic salmon, but separated by marked anatomical and physiological peculiarities.

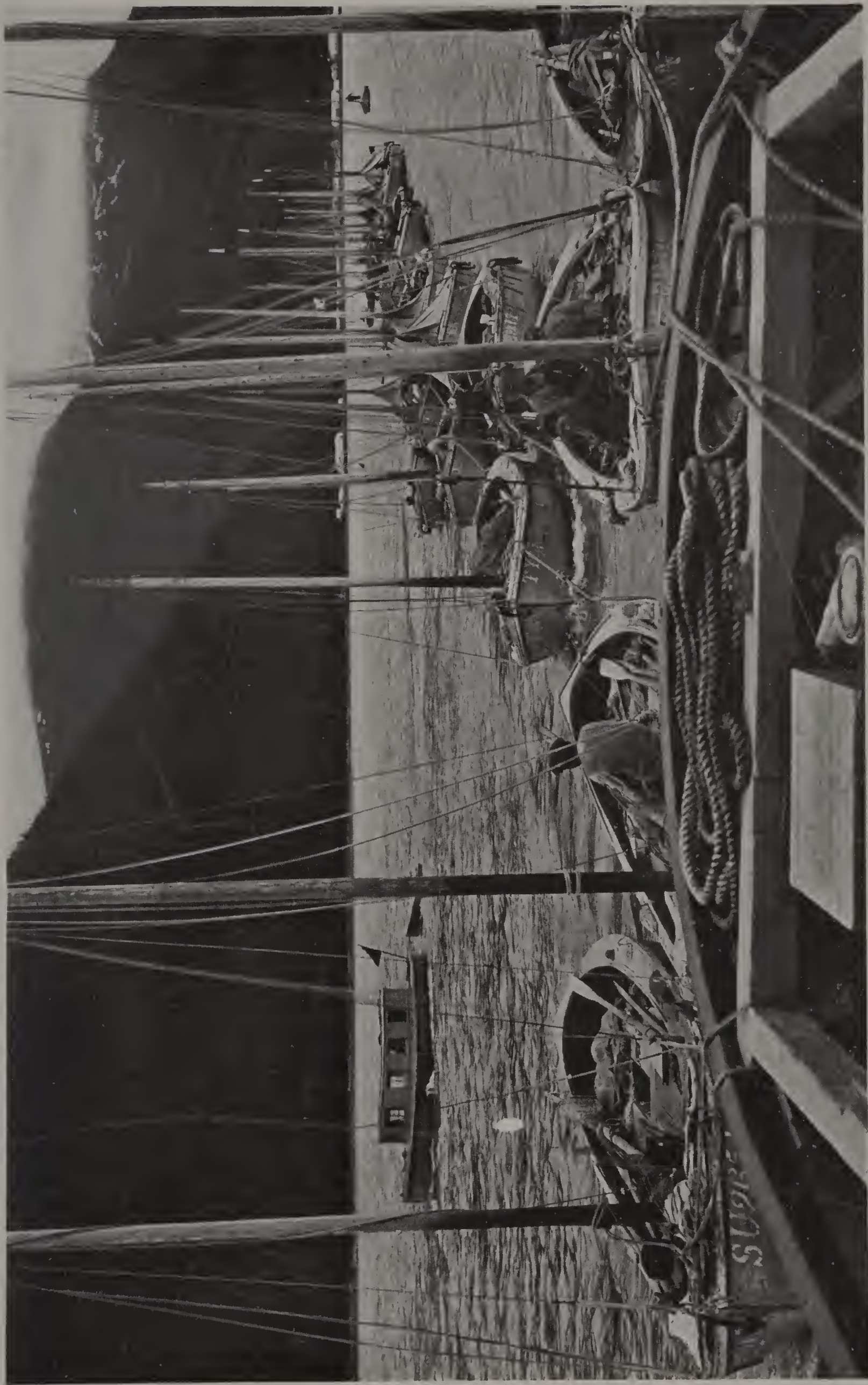
There are five distinct species, which, having many characters in common, nevertheless differ strikingly in size, color, habits, distribution, food value, and economic importance. All of the species occur on the California coast (to San Francisco Bay or a little farther south), and range thence to the far north, crossing to Siberia and reaching southward into Kamchatka, while three of them extend to Japan.

These fishes were first christened in a scientific way by the German physician Walbaum, who, in 1792, invested them with the vernacular names by which they were known among the Russians. The rules of nomenclature require that these names be retained, and hence these beautiful creatures must bear for all time such outlandish names as *kisutch* and *tschawytscha*. It was as late as 1861 that Dr. George Suckley, the naturalist of the Pacific Railroad Survey, recognizing the generic distinctness of these fishes from the ordinary salmons (*Salmo*), gave them for the first time a clan name of their own, *Oncorhynchus*, meaning hook snout.

The largest of the genus, and the most magnificent of all the salmons, is the Chinook, Quinnot, King, Spring, or Tyee salmon. It has an average weight of



Photograph by Shirley C. Hulse
A CHINOOK SALMON MAKING A LONG, CLEAN JUMP ONTO THE APRON OF A DAM: FISH 25 FEET FROM CAMERA



TOWING OUT THE FLEET OF SALMON SAILBOATS

Canada like the United States exercises close supervision over the salmon industry. Many of the finest salmon streams are located in British Columbia. The Canadian Government Fisheries Patrol boat is seen on the left.



Photograph from John N. Cobb

A REMARKABLE PICTURE OF SALMON SPAWNING ON A GRAVELLY RIFFLE IN A PACIFIC COAST STREAM

There are five species of Pacific salmon, and all of them have the remarkable habit of dying after once spawning. This applies to both sexes, and was a wise provision of nature to prevent overstocking. The only other American food fish with this habit is the common eel, which spawns and dies at sea.

nearly 25 pounds in the Columbia, and is often caught weighing 40 to 60 pounds, while occasionally examples of over 100 pounds are taken. While found from California to China, it attains its greatest abundance in the Sacramento, Columbia, Yukon, and other large streams.

The species called Blueback salmon on the Columbia, Sockeye on Puget Sound, and Redfish or Red salmon in Alaska, averages only five pounds in weight and never exceeds twelve. It attains greatest abundance in the Columbia, the Fraser, and in various streams throughout Alaska. Its meat is rich in quality and deep red in color, and the fish is therefore in great demand for canning. While a beautiful fish when in salt water, with bright blue back and silver sides, after entering fresh water it deteriorates rapidly in food value and appearance, the head turns to olive green, and the entire back and sides become crimson and finally dark blood red.

The Silver or Coho salmon, with a general distribution in the coastal streams, averages 6 pounds in weight and rarely exceeds 25 or 30.

The smallest species is the Humpback, so called from the well-marked nuchal hump developed by the male in fall. The extremes of weight for mature examples are 3 and 11 pounds, with 4 pounds as the average. The region of greatest abundance is Puget Sound to southeast Alaska.

The remaining species, the Dog or Chum salmon, averages 8 pounds in weight. It is generally distributed and abundant, but, owing to the poor quality of the flesh, is the least important of the group. The distortion of the jaws in the male during the breeding season, while characteristic of all the species, is particularly marked in the Dog salmon.

INEVITABLE DEATH AFTER SPAWNING

The differences in spawning times and places of the different species of salmon are most interesting. After spending most of their lives at sea, growing, accumulating fat, and storing energy, the salmons move inshore and ascend the streams. After once beginning their upward journey, they take no food, and in fact are physiologically incapable of digesting and assimilating food.

The Quinnsat salmon begins to run in spring and pushes its way to the head-

waters of the larger streams. In the Columbia basin the species distributes itself over 90,000 square miles of Washington, Oregon, Idaho, and Montana, its upward limit being insurmountable obstructions or falls. *In the Snake River and the Yukon River the spawning grounds lie 2,000 miles by water from the sea.*

The spawning streams of the Red salmon are those that arise in lakes, and the spawning grounds are in the affluents of those lakes. The run begins in May and fish continue to come in until October, depending on latitude.

The Silver salmon enters the streams from July to October or November, but does not as a rule ascend for long distances.

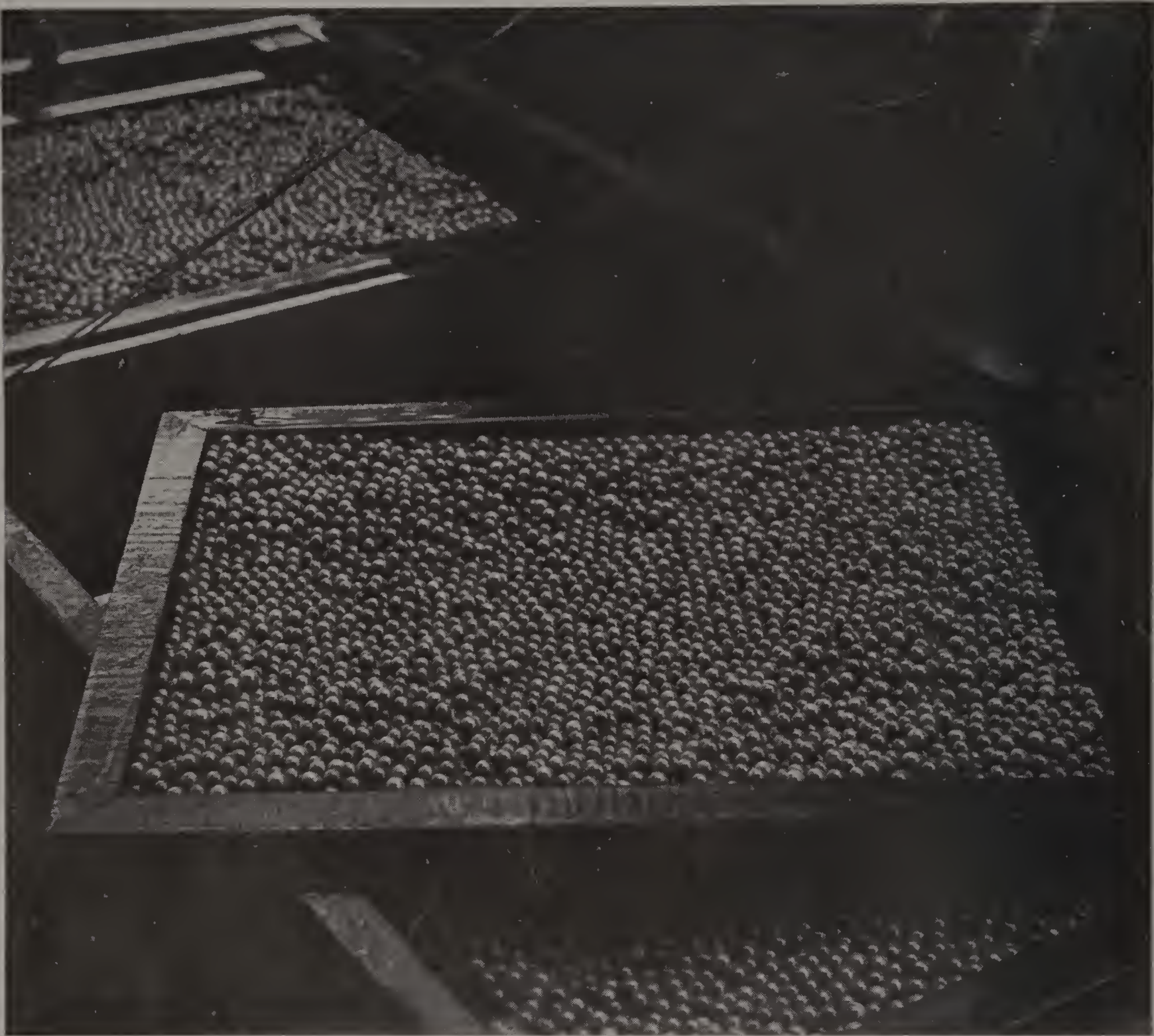
The Humpback runs into fresh water in summer and fall, preferably in short coast streams, and often spawns within a few rods of the ocean.

The schools of Dog salmon come into the stream rather late; in the Columbia River and Puget Sound the run extends from August to late in November, and in Alaska the height of the season is about the first of September.

Now, whether the salmon travel in the streams 2,000 miles or 200 feet to reach their spawning grounds, and regardless of their physical condition at the time they arrive at the particular places required for the proper development of eggs and young, every individual of every species dies shortly after spawning. This is the most characteristic and remarkable event in the life of the Pacific salmons.

Why this is the case is one of nature's mysteries. It has its parallel in some other fishes, in the may-fly, which perishes after a few hour's existence, and in the annual plants. We can only say of such that they have served their purpose and are no longer needed.

The death habit of the salmons was doubtless developed to prevent the overstocking of streams, the exhaustion of the food supply of the young while in fresh water, and the consequent danger of the wiping out of species by mere excess of numbers. This wise precaution of nature has become a positive detriment by the appearance of the human factor on the scene and the resulting destruction of a large proportion of the run of each species each year in practically every stream before the spawning act has occurred.



SALMON EGGS ON TRAYS READY FOR SHIPMENT

Eggs are packed in this manner for transfer between hatcheries and for distant shipment. The eggs packed in a case can, if kept cool and moist, remain out of water for several weeks without impairment. One hundred thousand eggs may be carried in a case.

PERIODICITY OF THE RUNS

While the Pacific salmons run with more or less regularity, year after year, two of the species exhibit, in particular streams or regions, a marked periodicity in abundance which is so well established that it can be predicted with certainty years in advance.

The Blueback, or Sockeye, in certain streams shows a climax in abundance every fourth year. This is especially marked in Puget Sound and Fraser River, where the years 1905 and 1909, for example, were characterized by immense runs, while in 1906 and 1910 the abundance, as shown by the catch, was only one-fourth or one-fifth as great. The quadrennial periodicity in Puget

Sound is strikingly shown by the fish caught and canned during the years 1903 to 1910, as follows:

1903.....	167,211 cases
1904.....	109,264 “
1905.....	825,453 “
1906.....	178,748 “
1907.....	93,122 “
1908.....	170,951 “
1909.....	1,097,904 “
1910.....	248,014 “

The case of the Humpback salmon in the Puget Sound region is perhaps the best marked example of periodicity. The species there is biennial in its appearance. One year it comes in incalculable numbers, crowding the streams, filling the nets, and giving canners all the raw ma-



Photograph by Shirley C. Hulse

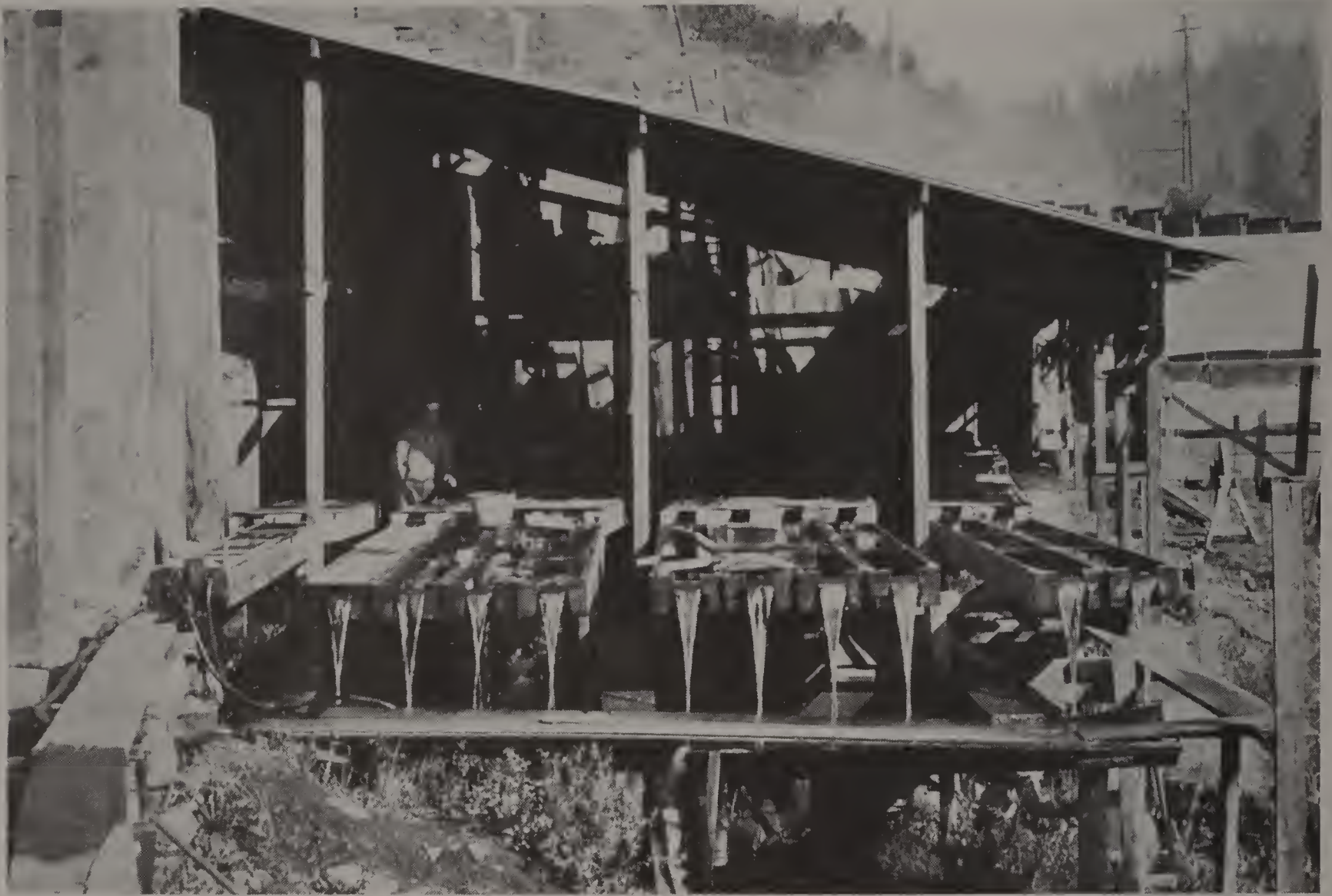
AN UNUSUALLY FINE MALE CHINOOK SALMON: WEIGHT, PERHAPS 60 POUNDS.
THIS IS THE MOST MAGNIFICENT OF ALL THE SALMONS

terial they can use. The next year the species is so scarce as to be practically absent.

In 1907 the Puget Sound canners prepared 433,423 cases of Humpbacks, but in 1908 they were able to secure only enough fish to make 6,075 cases. In 1909 the pack was 370,993 cases, while in 1910 only 108 cases could be filled. Again, in

1911 the pack was 1,046,992 cases while in 1912 the total was but 700. This alternation has continued to 1923 which was a year of abundance resulting in a pack of 475,849 cases.

This periodicity is an indication of the age of the fish when mature. In the case of the Blueback, a large run, with the deposition of a large quantity of spawn,



Photograph by Shirley C. Hulse

A FIELD HATCHERY OF THE STATE OF OREGON

Here the eggs are put in troughs of running water, in which they hatch after a greater or less period, according to the temperature of the water. The eggs are picked over every day and all sterile or objectionable ones are thrown out. It is necessary to screen the troughs at this place on account of birds, which enter boldly and steal the eggs. The water ousel is the worst of these thieves.

has its major effect four years later in the same region—that is, the normal life of this species, from its birth as an egg to its death as a parent, is four years. The Humpback, on the other hand, is a biennial species, a heavy run, with a corresponding egg crop, having its effect two years later. Dr. Charles H. Gilbert, who has made prolonged studies of the Pacific salmon in the interests of the government, announces, as a practically accurate statement of fact, that the Humpback dies on its second birthday.

THE SALMON'S "INSTINCT OF NATIVITY" AND THE PARENT-STREAM THEORY

In view of the excellent quality of the Humpback and its growing importance as a fresh and preserved fish, the government now proposes to make a determined effort to establish in Puget Sound a large run during the off years. This experiment will extend over several seasons, and will involve the transfer from Alaska of perhaps a hundred million Humpback eggs for hatching on Puget Sound. If

successful it will prove tremendously important commercially, and incidentally the efficacy of artificial propagation will be submitted to a crucial test.

One of the most deeply seated and widely entertained theories regarding the salmons (and other species of similar habits) is that by virtue of a mysterious faculty, which has been called the instinct of nativity, these fishes return to spawn in the same stream in which they were hatched.

The advocates of this view find support for it in some well-known facts in the life of the salmons, such as the occurrence of distinctive runs in particular streams, the return of marked fish, response to plants of large numbers of young, etc. Without entering into a discussion of this question, it may be said that in so far as the theory is borne out by facts, the latter may be explained without the necessity of investing the salmon and other anadromous fishes with a higher order of intelligence than is possessed by any other creatures.



Photograph by Shirley C. Hulse

THE CAZADERO DAM, ON THE COLUMBIA RIVER, OREGON

Note the fish ladder just to the right of the dam. The fish attack the fall along its entire length. The Cazadero Dam is 40 feet high, so of course it is impassible, but the fish never seemed discouraged. Morning and evening, all during the run, they leaped at the foot of the apron, apparently undaunted by the heavy blows received in landing on the bucket or the rocks. The hatchery is located in a curve of the big flume leading from the dam, and about a quarter of a mile downstream.

It is true as a general proposition that the fish hatched in a particular stream return to that stream to spawn, but this is largely because that is the most natural and most accessible place to go, and it is more remarkable when they go elsewhere, as they frequently do.

SALMON'S INSTINCT NOT UNFATHOMABLE

The schools of salmon when sojourning in the ocean, preparing for their all-important function, do not roam many miles distant from the mouth of the particular stream in which they were born and spent the early months of their life. Having reached the proper age, they are impelled by the spawning instinct to move shoreward, and they eventually come within the influence of the fresh water discharged into ocean, gulf, or bay by a stream that is more likely to have been the "parent stream" than another. It thus happens that streams pouring a vast volume of fresh water into the sea, like the Columbia and Fraser, and streams whose mouths are more or less remote from others, like the Sacramento,

are likely to induce the return of a large proportion of the fish that originally proceeded therefrom.

On the other hand, there is no reason to doubt that the salmon spawned in contiguous coastal streams or in particular tributaries of a large river return indifferently to any of those streams or tributaries, depending on conditions (storms at sea, floods, temperature of coastal or river water, enemies, etc.), which vary from season to season.

GOVERNMENT AND STATE EFFORTS TO INCREASE THE SALMON SUPPLY

The artificial propagation of salmon in the streams of the Pacific seaboard began at a comparatively early date and has continued with yearly increasing extent and importance, so that at the present time more hatcheries are devoted to the Pacific salmons than to any other fishes of the Western Hemisphere. The vast interests at stake have appeared to warrant and to require all the money that could properly be expended by the Federal and State governments for salmon culture.



Photograph by Prof. Henry B. Ward

SALMON BELOW AND IN A FALLS IN AN ALASKAN STREAM

The leaping powers of the salmon of the North Atlantic have been amply praised in prose and poetry. Not less worthy of admiration are the skill, zeal, and persistence with which the North Pacific salmon overcome obstacles, ascend rapids and cascades, and surmount falls while on their way to their spawning grounds. The bull-dog pertinacity with which the fish continue on their course while rapidly undergoing physical deterioration has hardly a parallel in the whole fish tribe. In the Snake River and the Yukon River they travel 2,000 miles from the ocean, and after once beginning their upward journey they take no food of any kind. Every individual of every species of salmon dies shortly after spawning.

It was believed at the outset that dependence would have to be placed on artificial propagation to offset the tremendous drains made on the supply by man and other destructive agencies, and it was generally maintained at a very early period in the history of the salmon industry that with adequate cultivation the fisheries could increase almost indefinitely.

The first salmon hatchery in the West was established in 1872, on the McCloud River, in California. By executive order there was set aside a large tract for a "piscicultural preserve," which was fittingly named Baird, after the first national commissioner of fisheries; and Livingstone Stone, a pioneer fish culturist, was placed in charge and continued in that capacity for many years, overcoming many obstacles, undergoing many privations, repeatedly subjected to great danger from attacks of Indians and outlaws, while devising methods which showed the possibilities of salmon culture and led to the present extraordinary development of this art.

THE VAST EXTENT OF SALMON CULTURE

The original Baird hatchery, still in active operation, is now supplemented by numerous other government stations, which may be regarded as lineal descendants. Three of these are in the Sacramento Valley, in California; four are in the Columbia basin, in Oregon and Washington; seven are in the Puget Sound and adjacent Washington region, and two are in Alaska. The three Pacific-coast States now maintain more than 30 salmon hatcheries, the largest number being in Washington.

A feature of the salmon industry which is not met with in any other branch of the fisheries has been the establishment and maintenance by private interests of hatcheries at various places on the coast. At present this practice is confined to Alaska, where, in 1911, five hatcheries belonging to canning companies produced and liberated many millions of young red salmon.

The eggs of the salmons are .2 to .25 inch in diameter, and are the largest handled by the fish culturist. They are easily obtained by intercepting the fish on their way to the spawning grounds by means of racks, traps, seines, etc., and then, when exactly ripe, by expressing by firm pressure on the abdomen.

The size and activity of the salmons make it necessary for two or three men to work together in holding the fish and relieving them of their eggs and milt, and the largest individuals are most readily managed by putting them in a straight jacket.

In view of the inevitable death of the salmon after spawning, an improvement over the old method of forcible expulsion of the eggs is the stunning of the fish by a blow on the head and the taking of the eggs by abdominal section. This, while greatly facilitating the work of the spawn-takers, adds approximately 10 per cent to the egg yield by the saving of eggs that would ordinarily be left in the abdominal cavity.

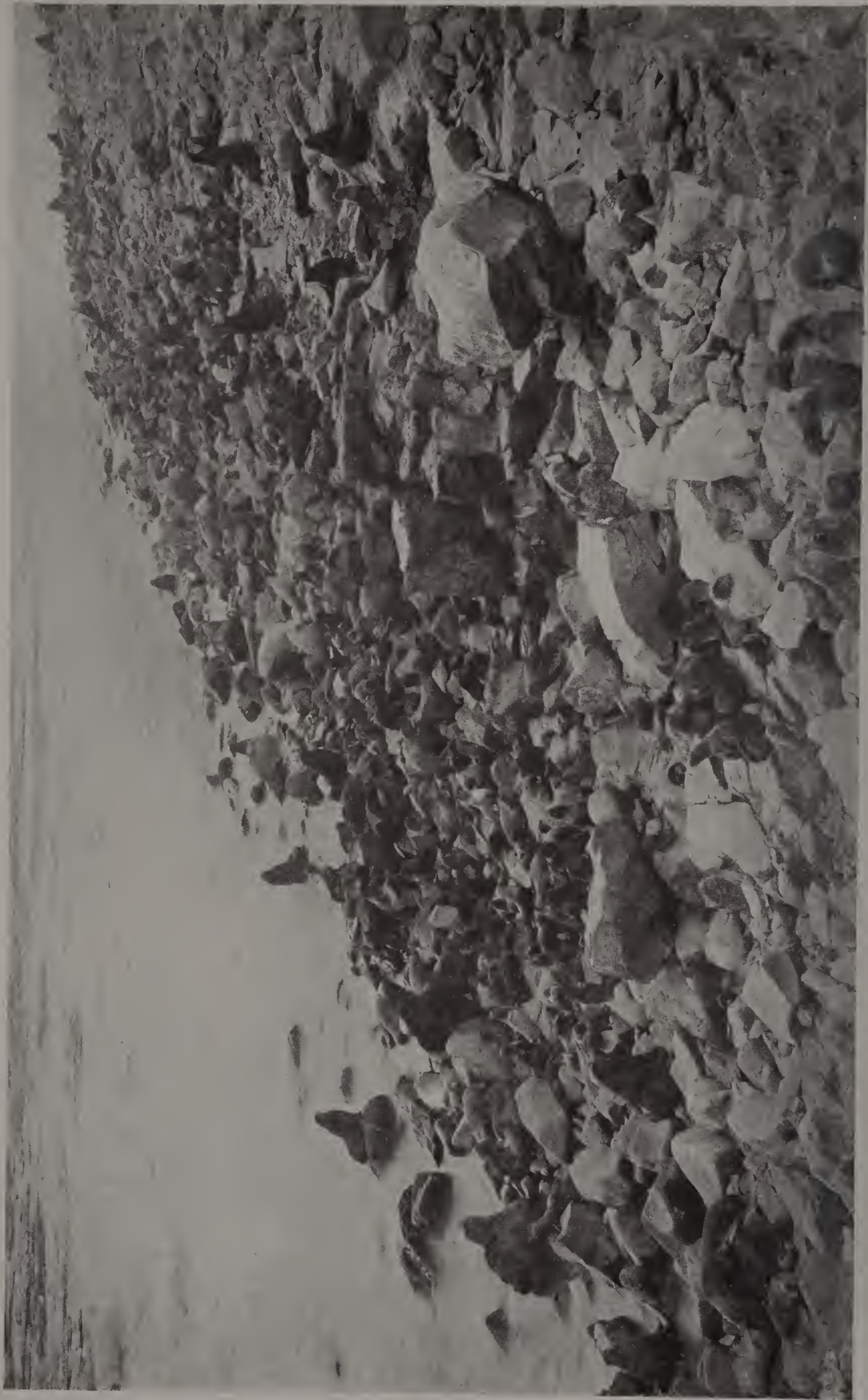
Salmon eggs hatch slowly. Incubation, beginning in late summer or early autumn, continues until the following spring or summer, depending on the temperature of the water. The most protracted period of incubation thus far coming to the notice of fish culturists is that of the red salmon at Karluk, Alaska, where eggs taken in September may not hatch until the following May or June, and in certain seasons the hatching time has been prolonged to 270 days.

The annual deposits of young salmon in the waters of the Pacific seaboard by the Bureau of Fisheries, the three coast States, the province of British Columbia, and the private hatcheries in Alaska now total from 450 to 500 million, of which the largest quantity represents the work of the Federal government.

The human effort represented by this tremendous output may perhaps be better appreciated when a season's take of eggs is considered as a commodity. The average number of salmon eggs to a bushel may be given at 125,000. The number of eggs taken, fertilized, and incubated by the United States Bureau of Fisheries at its California, Oregon, Washington, and Alaska hatcheries in 1911 was equivalent to 1,500 bushels. The salmon-egg harvest of the other efficient agencies indicated would bring the yearly total up to 4,500 bushels.

HOW MAN IMPROVES ON NATURE

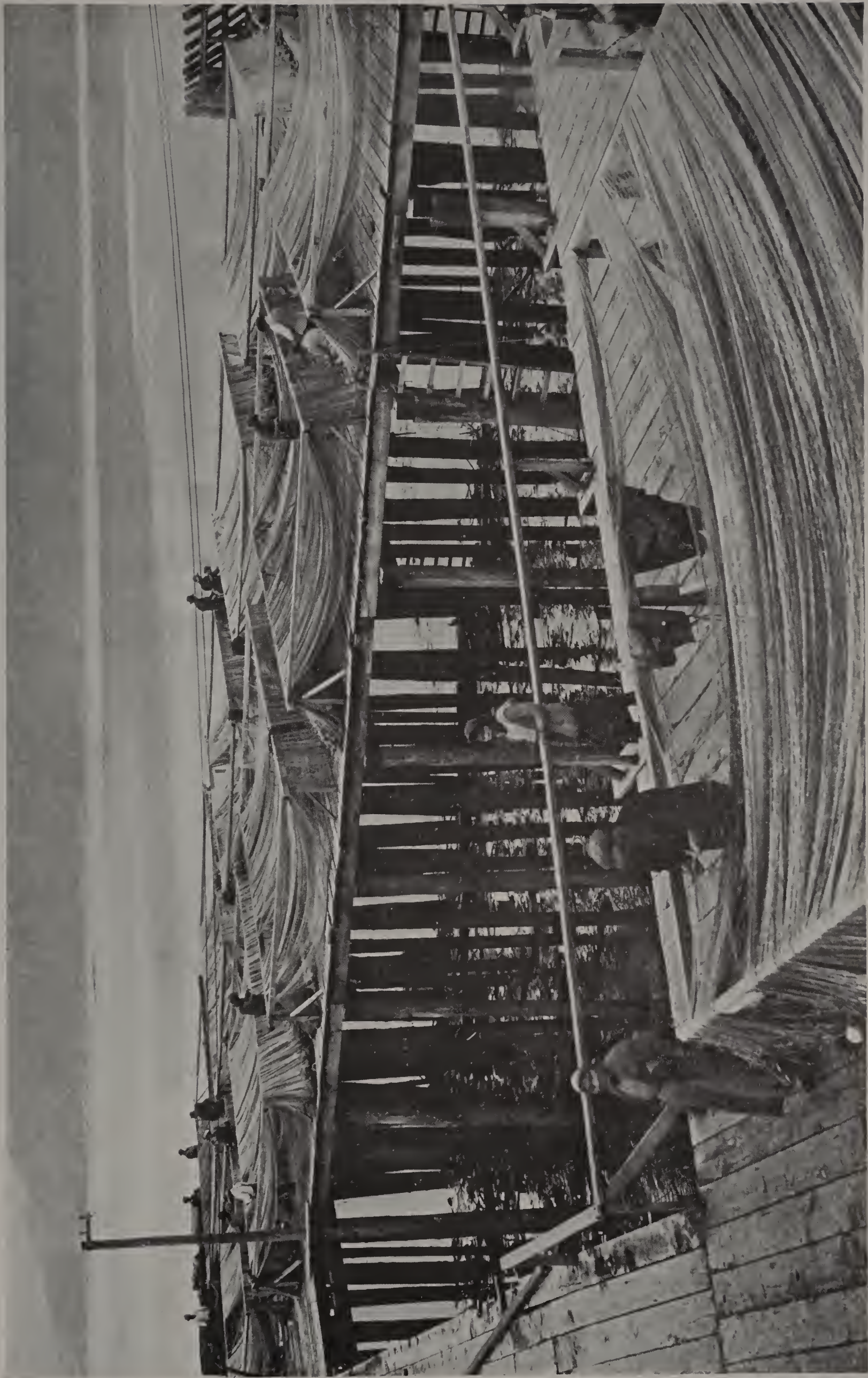
In the discussions of important economic questions affecting natural resources, especially animals, the contention is sometimes made that man cannot improve on nature's methods. This plea, which impresses many people and con-



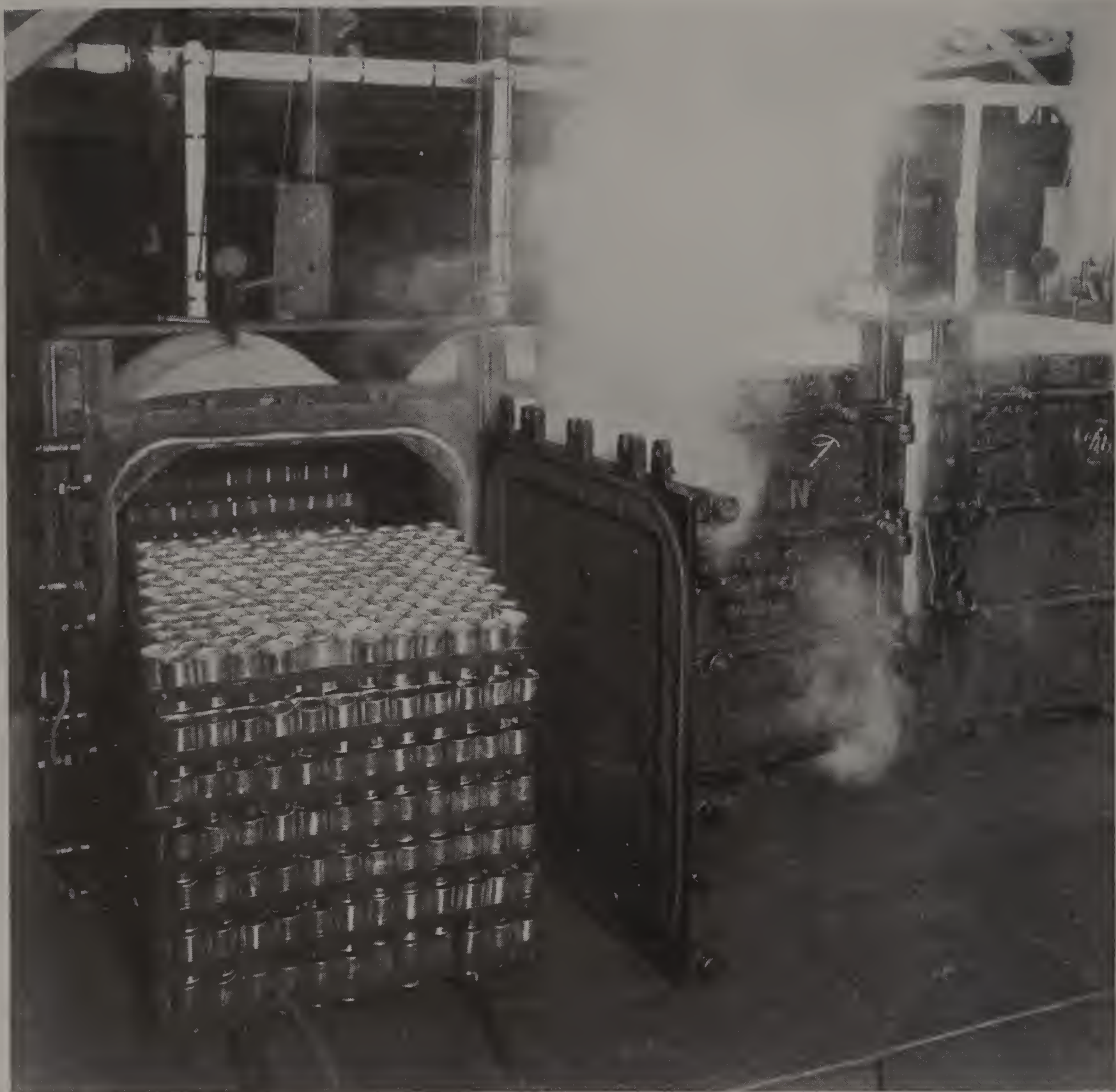
Photograph from U. S. Bureau of Fisheries

A HERD OF ALASKAN FUR-SEAL—ANOTHER PRODUCT OF PACIFIC WATERS

After being sadly decimated by indiscriminate slaughter at sea, the herd has been rapidly recuperating under the influence of an international agreement, and soon the fur-seals may be as numerous as when they came into the possession of the United States Government with the purchase of Alaska.



DRYING AND MENDING SALMON NETS AT BALMORAL CANNERY ON THE SKEENA RIVER, BRITISH COLUMBIA



Photograph by Curtis & Miller

A RETORT WHICH COOKS TWO THOUSAND CANS OF SALMON AT A TIME

Here they are given the final cooking under steam pressure. While large quantities of salmon are sold in a fresh, salted, or smoked condition, by far the major part of the catch is canned.

duces to neglect of the needs of some of our most valuable creatures, is most emphatically and clearly refuted in salmon culture.

It is a matter of general observation that nature is most prodigal in producing fish eggs and young far in excess of the needs of the species, and permitting the destruction of a very large percentage of the progeny before maturity is reached. With the advent of the human factor, there is a disturbance of the nice balance that had come to be established, and it is then that fish culture is demanded and justifies itself by saving a large propor-

tion of the eggs and young that are ordinarily sacrificed.

MAN MORE EFFECTIVE THAN NATURE

Just how effective are the operations of the salmon culturist, and how strongly artificial propagation is now demanded because of the enormous drains that are made on the small remnants of the original progeny that have reached the reproductive age, may be seen from the following comparison:

Under ordinary conditions of natural propagation, a certain small percentage of the ripe eggs are not extruded, but

remain within the body of the female, and are therefore wasted; from 10 to 20 per cent of the total number of eggs escape fertilization; a very large proportion (60 to 80 per cent) of the eggs are destroyed by predaceous fishes and other agencies; and, while the newly hatched young are in the helpless non-swimming stage, burdened by the heavy yolk-sac, they are such easy victims and such dainty morsels to the myriads of fishes that infest the spawning grounds, that an additional loss of 10 to 15 per cent occurs, so that of the original crop of eggs, only 1 to 2 per cent reach the age to which the fish culturist carries the young salmon.

Under the present effective methods of artificial hatching, the total losses up to the time when the young are set free in the rivers, amply able to care for themselves, although still liable to considerable mortality before reaching the ocean, are not more than 20 per cent, are frequently only 10 per cent, and should not exceed 15 per cent under average conditions.

Therefore, as against an absolute loss of 98 or 99 per cent in nature, the fish culturist is to be credited with a saving of 85 per cent.

The natural mortality among young salmon in the rivers decreases rapidly as the fish become stronger, more active, and more alert. The most important advance that salmon culture can make will therefore be in retaining the young at the hatcheries for a longer period before turning them loose in open waters to shift for themselves. There is no particular difficulty in rearing salmon in captivity; the difficulty lies in providing at a given hatchery the necessary artificial pond area in which to hold and feed perhaps 100 million rapidly growing fish.

EXTENT OF THE SALMON INDUSTRY

The salmon industry on the Pacific coast owes its origin, rapid development, and present extent to the establishment of canneries. During the 60 years that have elapsed since salmon canning began, more than 175 million cases (each holding 48 one-pound cans or the equivalent) have been packed. The fresh weight of the salmon entering into this output has been over ten billion pounds.

Recent years have witnessed marked changes in the relative amounts of salmon canned, salted, and sold fresh or refrigerated, but much the largest proportion of the catch is still canned, and this will necessarily be the case for years to come.

Salmon fishing is conducted throughout the range of the salmons, but the industry is most extensive in or near the mouths of certain streams, chief of which are the Sacramento, Columbia, Fraser, Skeena, Karluk, and Nushagak. Most of the fishing in Alaska is in bays, straits, and sands adjacent to small streams.

ALASKA'S ENORMOUS SALMON RESOURCES

In one year the aggregate catch of salmon in the Pacific States, British Columbia, and Alaska was upward of four hundred million pounds, which, as sold in a canned, salted, smoked, frozen, or fresh condition, had a market value of about \$27,750,000. The canned product alone, consisting of more than five million cases of 48 one-pound cans, was worth \$25,500,000. Thirty-five thousand people were engaged in the different branches of the industry, and the invested capital was fully \$30,000,000.

Many years have elapsed since Alaska ceased to be "Seward's Folly," because Alaska for a long time has annually more than repaid her purchase price in salmon alone. The salmons have in fact been Alaska's most valuable contribution to the world's needs, exceeding in abundance and importance those of any other region.

The salmon industry may be said to have begun in 1878, when the first cannery was operated. The exploitation of the different sections has progressed rapidly, and in 1917 the catch was the largest ever made, amounting to about seventy million fish, weighing about three hundred and sixty million pounds.

While all of the five species occur in Alaska, they differ markedly in distribution and relative abundance. The Red salmon is most numerous in central and western Alaska, where three-fourths of the catch is obtained. On the other hand, nine-tenths of the output of Humpbacks and a large proportion of the other species come from southeast Alaska. The preponderance of the Red and Humpback



Photograph by Shirley C. Hulse

SALMON LEAPING OVER THE SWIFT WATER NEAR THE TOE OF CADAZERO DAM
AND SEEN FROM ABOVE

species is shown by the fact that of the forty-four million salmon utilized in 1911, about seventeen and one-half million were the former and twenty-one and one-half million the latter.

To have transported, in a fresh condition, the output of 1917 would have required a train of 12,000 freight cars, each holding 30,000 pounds of fish. If placed end to end, the fish would have extended in an unbroken line five times across the continent from New York to San Francisco.

FEDERAL GOVERNMENT SUPREME IN
ALASKA

Interest in the salmon fisheries of Alaska is increased by the fact that they are under the jurisdiction of the Federal government. The remarkable development of the industry and its flourishing condition are to be attributed in great measure to the wise policy adopted by the government in encouraging the utili-

zation of the resources while safeguarding the supply. Under the wise laws made by Congress, supplemented by the large discretionary powers invested in the Secretary of Commerce, the salmon fisheries ought to remain unimpaired for an indefinite period.

UNITED STATES CONTROLS INDUSTRY

The major key to the situation is the authority to close to all fishing for a term of years any stream in which the extent of the fishing is disproportionate to the number of fish that are allowed to reach their spawning grounds.

Although the fishery force available for patrolling the Alaska coast is woefully inadequate, yet even in the most remote and seldom visited parts there is a wholesale sentiment for salmon protection, and violations of the law are surprisingly few.

The large fishing companies, with immense vested interests, are vitally con-



Photograph by Shirley C. Hulse

FERTILIZING THE SALMON EGGS: OREGON

It sometimes requires two men to handle a large buck. As soon as the "milt" is in the pan with the eggs, a little water is added and the whole stirred until the mass of eggs is thoroughly impregnated.

cerned in the perpetuation of the salmon supply, and are willing to meet the government half way in inaugurating and enforcing measures for the prevention of overfishing or other destructive methods.

One of the most novel and interesting pieces of work conducted by the Bureau of Fisheries in connection with the administration of the Alaska salmon fisheries is the taking of a census of the spawning salmon moving up one of the

principal streams in the territory. The results and the purport of this effort are most important, and a brief account is not out of place here.

Since 1907 Nushagak and Wood rivers, which flow into Nushagak Bay, in western Alaska, have been closed to commercial fishing by virtue of the power conferred by law on the Secretary of Commerce. In 1908, through the liberal coöperation of two salmon companies operating in the region, the Bureau at

great expense and labor, placed across Wood River an intercepting rack, which compelled all migrating salmon to pass through narrow tunnels or gates provided for the purpose and so arranged that the fish would be readily visible to persons on watch.

Men provided with an automatic counting and registering device were stationed on the rack night and day and kept a tally of the salmon as they passed upstream. The run continued during all of July and part of August, and on one day over 324,000 fish were recorded, and on another more than 402,000. The total tally was 2,603,655 salmon, all of the red species.

These were fish that had escaped the very active fishing in Nushagak Bay, and in addition to them several million other fish are known to have gone up other tributaries of the bay to their spawning grounds, the data available indicating that the total run of red salmon in the Nushagak basin in 1908 was as many as 13,600,000, with 10,100,000 as the minimum, of which 6,400,000 were caught and utilized at the local canneries.

Therefore, under the most favorable conditions for reproduction, nearly 53 per cent of the run escaped, and under the most unfavorable 37 per cent.

TAKING A SALMON CENSUS

During each of the three following years the rack was reconstructed at the same place, and the census of the run was taken in the same way, with the following results: 1909, 893,244 fish; 1910, 670,104 fish; 1911, 354,299 fish.

In 1912, the fourth year of the rack test, a large run corresponding to the run of 1908 was expected. Only 325,264 fish were counted, however, but for some unaccountable reason a big run occurred in 1913 totalling 735,109 fish. No work was performed during 1914. In the following two years the run was low according to expectations and then came in large in 1917, the fourth year after the large 1913 run. Again the count fell off in 1918 and 1919.

It was thought that this experiment and similar trials in other streams would afford accurate data relative to the natural increment of the fish, so that the approximate size of the run being known, the minimum number of fish necessary to maintain the supply may be allowed to pass to the spawning grounds each year and the remainder of the run placed at the disposal of the fisherman. Except for the off year of 1912 the test has provided suitable data for such a determination.



Oysters: A Leading Fishery Product

By HUGH M. SMITH

Former United States Commissioner of Fisheries

OYSTERS are the most popular and most extensively eaten of all shellfish; economically, they are the most important of all cultivated water products and, with the single exception of the sea herrings, the most valuable of all aquatic animals. Zoologically considered, oysters are lamelli-branchiate mollusks of the genus *Ostrea*.

In at least 35 countries oysters support a special fishery, and in various other countries enter into the food supply. On the shores of all the temperate and tropical oceans and seas, oysters occur in greater or less abundance; but the supply in the North Atlantic exceeds that of all the other waters combined. Not less than one hundred and fifty thousand men and women are engaged in the oyster industry; and the capital invested in vessels, boats, apparatus, oysterlands, and cultural establishments aggregates many million dollars.

The oyster crop of the world at the present time amounts to over twenty-two million bushels and is valued at nearly \$20,000,000. Of this output, the share of the United States is 79 per cent of the quantity and 63 per cent of the value. Of the remaining portion the greater part belongs to France.

At least one hundred species are known, with a rather wide range in size, shape, habits, flavor, and food value. Some excellent species exist in the equatorial and sub-tropical regions, but the best occur in temperate climes. The northern limits of their habitat are the Gulf of St. Lawrence and southern Norway in the Atlantic, and Hokkaido and Puget Sound in the Pacific.

Oysters produce an immense number of young in order to compensate for the heavy mortality that occurs at all stages of growth, but particularly in the early months. It is an astonishing biological fact that in some species of oyster each sex is represented by a different individual, as in the oyster of the Atlantic coast of North America: while in other species both sexes are united in one in-

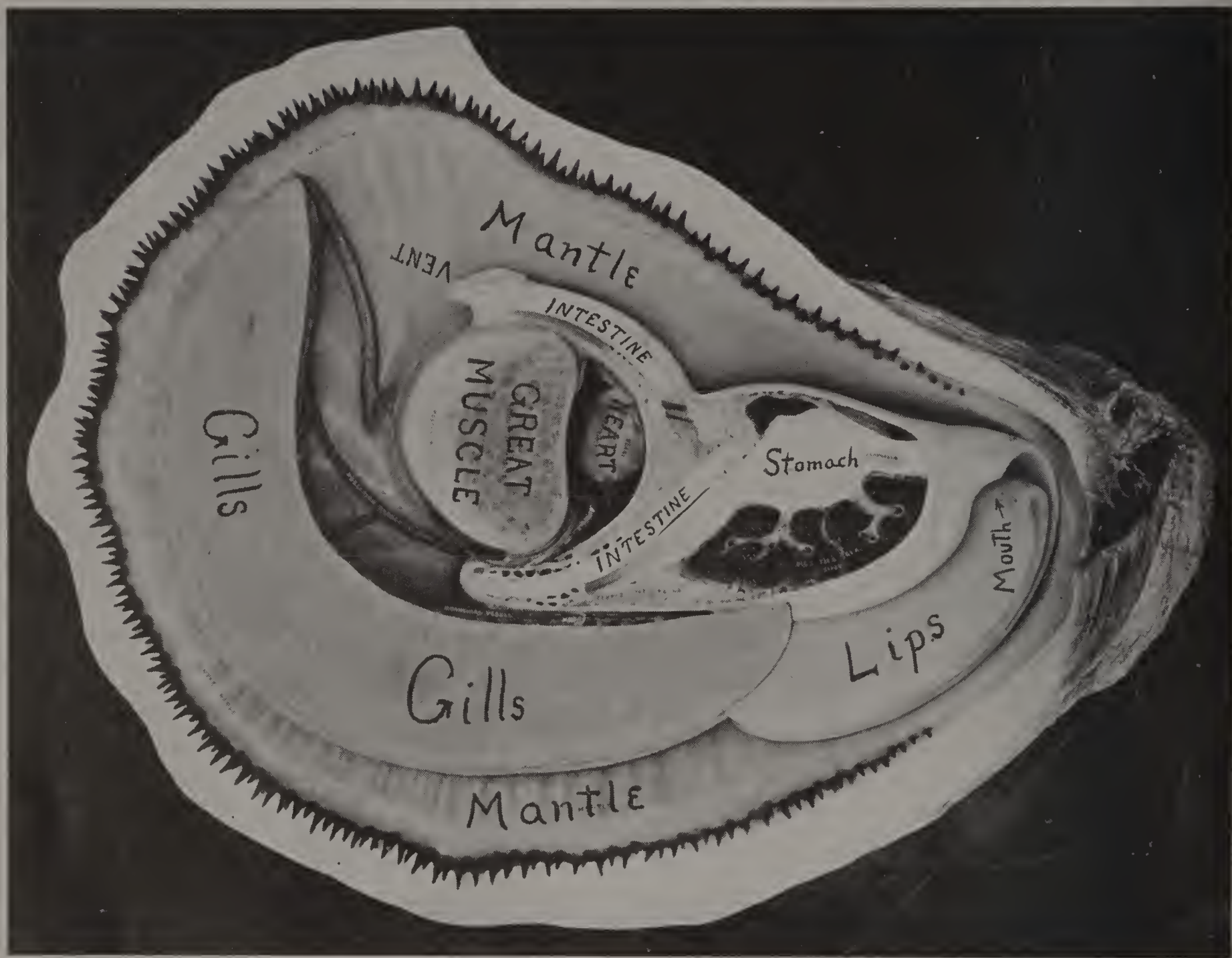
dividual—the male stage alternating with the female, as in the common oyster of the Atlantic coast of Europe.

After the oyster attains a size that is visible to the unaided eye, it is incapable of changing its position. This is in marked contrast with the newly born young, which is a free-swimming creature, floating about with tides and currents, and quite as likely to settle down on a far-distant bank or bar as to rejoin its progenitors.

Of the millions of microscopic young liberated by a single full-grown oyster, only an exceedingly small percentage become attached to a suitable bottom, form a shell, and enter on a career that will terminate on the table in two to four years. When the temperature, density, tides, and currents are favorable, the young will settle on an existing bar or bed, covering the shells of the old oysters and any other hard surfaces or objects that may be present. All the young that fall on a muddy or soft sandy bottom, or on surfaces that are slimy, are lost. Oyster culture therefore aims primarily to conserve the free-swimming young, which it accomplishes by sowing clean oyster-shells or other “cultch” to which the “spat” can attach, or by collecting the young on tiles or brush raised above the bottom or suspended between surface and bottom.

CHINA AND ITALY CULTIVATED OYSTERS 2,000 YEARS AGO

Oysters have been under culture longer than any other shellfish and, indeed, than any other water creature. A simple type of cultivation, with the formation of artificial beds, flourished in China at a very remote period and probably antedated by some centuries the inception of oyster culture in Italy, about the year 100 B. C. With the advance of civilization and the increase in population, oysters were in greater demand and of necessity came under cultivation in all the important maritime countries of Europe,



Photograph from Dr. Hugh M. Smith

ANATOMY OF THE OYSTER

"It is an astonishing biological fact that in some species of oyster each sex is represented by a different individual, as in the oyster of the Atlantic coast of North America; while in other species both sexes are united in one individual—the male stage alternating with the female, as in the common oyster of the Atlantic coast of Europe."

where, at the present time, fully 90 per cent of the output represents oysters that have undergone some kind of culture. In other parts of the Old World the growing of oysters by artificial means has become an important industry, while in the Western Hemisphere oyster farming has progressed to such a point that the annual crop now exceeds the total product of the rest of the world.

Oysters are thus become the most extensively cultivated of all aquatic animals, and the yearly product of the oyster farms is many times more valuable than that of all other aquicultural operations combined.

The cultivation of oysters is made necessary by the exhaustion of the natural beds; it is made possible by private ownership or control of oyster-producing

bottoms; and it is greatly facilitated by the peculiar susceptibility of oysters to increase and improvement by artificial means.

THE OYSTER HAS MANY ENEMIES

The human animal is not the only one that looks with favor upon the edible qualities of the oyster. At every stage in its career it is attacked by a horde of dangerous enemies, some of which are most destructive after the oyster has put on its stoutest armor and would seem to be almost invulnerable. Before it becomes attached, the delicate oyster fry is extensively consumed by adult oysters and various other shellfish, as well as by fishes like the Menhaden, which are able to strain their food from the water. When the oyster attains its shell, a new



Photograph from Dr. Hugh M. Smith

OYSTERS ENCUMBERED WITH A MASS OF EGGS OF THE WHELK

When the eggs hatch, the young wheelks will devour young oysters by boring through the shell.



INSPECTING A JAPANESE OYSTER CROP

The great rise and fall of the tides in Japan is of considerable advantage to the oyster farmer, enabling him to keep his crop under direct observation during the entire period of growth.



Photograph from Dr. Hugh M. Smith

STARFISH ATTACKING AN OYSTER

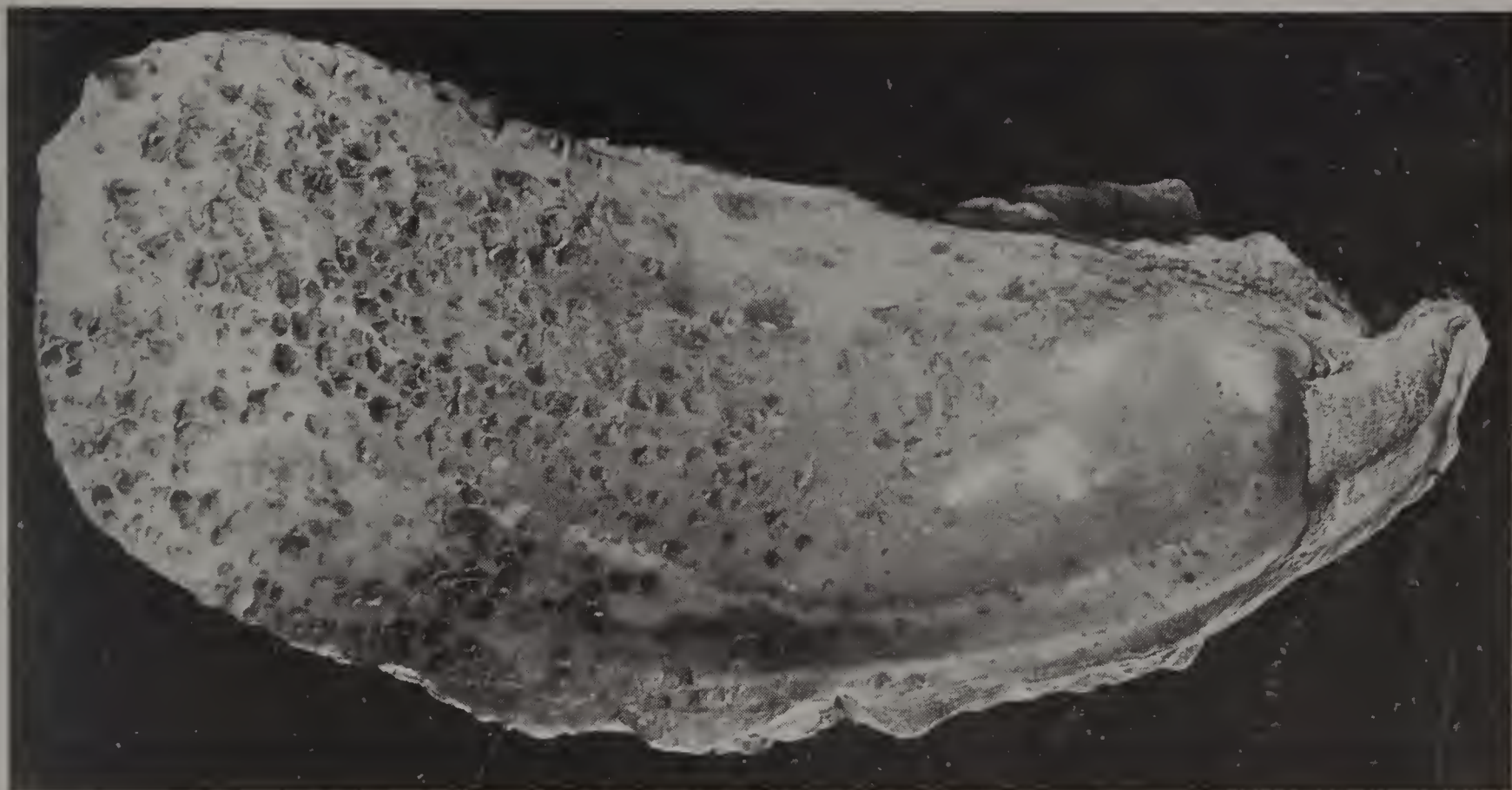
The weak conquers the strong when the starfish come in out of deep water to raid an oyster bed. A test of endurance takes place as the starfish clamps itself over the lips of a rough oyster shell. Doggedly it clings until the muscle holding the shell together relaxes from fatigue. Then the starfish inserts its stomach and swallows the tender helpless organism.

set of shellfish enemies, provided with drills, begin their attacks and extract the soft parts through minute holes made in valves. In some localities various snail-like mollusks do immense damage to the beds of oysters in their first year.

The oyster growers of Long Island Sound and adjacent waters suffer large losses from the inroads of starfishes, which come in from deep water and move in waves over the bottom, devouring every oyster in their path and sometimes destroying several hundred thousand bushels of marketable oysters in one State in a single season. It is remarkable that a weak creature like the common starfish should be able to prey on an animal so strongly fortified as an oyster. The starfish acts by attaching

itself to the lips of the oyster-shell and exerting a steady and long-sustained traction with each of its numerous small suckers. After a time the powerful adductor muscle of the oyster becomes fatigued, the valves open, and the starfish inserts its stomach and devours the helpless oyster at leisure.

Other enemies of the grown oyster are fishes with powerful jaws armed with crushing teeth. On the Atlantic coast the most destructive fish is the Black Drum, a school of which may literally clean out an oyster-bed in one night. On the Pacific coast a species of stingray is the chief offender, and to stop its ravages the oyster growers have been obliged to inclose the beds with stout palisades.



Photograph from Dr. Hugh M. Smith

VERY YOUNG OYSTERS ("SPAT") ATTACHED TO THE INSIDE OF AN OYSTER SHELL WHICH HAS BEEN "PLANTED" FOR THIS PURPOSE

The planting of suitable material, such as old shells, gravel, etc., to which young oysters may attach themselves after the free-swimming stage, is an exceedingly important branch of the oyster industry, for any of the young falling on mud or sand are lost.

Further damage is done to oysters by the encroachments of mussels, barnacles, sponges, etc., which sometimes occur so densely on the shells as to cut off food and oxygen and thus greatly retard the growth of the oysters.

OYSTERS ARE CHEAPEST AND MOST POPULAR IN THE UNITED STATES

In any consideration of the world's oyster industry the United States necessarily receives first and most prominent mention, for there is no country in which oysters occupy a more important place. The output here is larger and more valuable than elsewhere, and the relative importance of oysters compared with the total fishery product is greater. Furthermore, among the leading oyster-producing countries the cost of oysters to the consumer is least and the per capita consumption is greatest in the United States. Additional evidence of the conspicuous position held by the oyster is seen in the facts (1) that it is taken in every coastal State except one; (2) that in 15 States it is the chief fishery product, and (3) that it is the most extensively cultivated of our aquatic animals.

The annual oyster output at this time

is about seventeen million bushels, with a value to the producers of nearly \$13,000,000. The yield increased 70 per cent in quantity between 1880 and 1912. During the past decade there has been a slow decrease in the size of the crop. The limit of production has perhaps been practically reached in certain States, but in most States the industry is capable of great expansion. In recent years the South Atlantic and Gulf States have experienced a noteworthy augmentation of yield as a result of increased appreciation of the oyster resources and increased encouragement given to oyster culture.

The seven leading oyster States at this time are Rhode Island, New York, New Jersey, Maryland, Virginia, Mississippi and Louisiana in each of which the production ranges from a million bushels upwards. Maryland is the ranking State as regards production with four and one-half million bushels, followed by Virginia with three and one-fourth million bushels and New Jersey with one and one-half million bushels. As regards value of oysters taken Maryland leads with \$2,291,120 followed closely by Virginia with \$2,167,923 and New Jersey with \$2,070,496. A bushel



Photograph from Dr. Hugh M. Smith

OYSTERS GROWING ON AN OLD LANTERN

The tendency of the oyster to attach itself to any convenient object has been made use of by the oyster culturist from time immemorial. The Romans cultivated the oyster, particularly at Lake Avernus, and the traditional method of culture is still practiced today at Lago Fusaro, near Naples.

of oysters in New York brings the oyster-man \$1.30 while a bushel in Maryland brings 50 cents and a bushel in Louisiana 44 cents.

CHESAPEAKE BAY IS THE WORLD'S GREATEST OYSTER GROUND

The body of water which produces more oysters than any other body of water in the United States or, in fact, in the whole world, is Chesapeake Bay. The latest statistics of the oyster industry show the preponderating importance of the bay: an output of over seven and

three-fourths million bushels, valued at \$4,460,000, or 35 per cent of the quantity and 22 per cent of the value of the entire oyster crop of the United States for 1920.

While the oyster yield of Chesapeake Bay and tributaries in all recent years has been considerably less than formerly, nevertheless the industry today is in a healthier condition than ever before. This apparently paradoxical statement is explained by the fact that whereas in earlier years a very large proportion of the product was obtained from public beds, whose depletion had already begun and whose ultimate destruction was inevitable, now an annually increasing proportion of the oyster output is taken from grounds under private control and represents an actual aquicultural crop.

In Virginia about 50 per cent of the value of the State's oyster industry is contributed by grounds under cultivation, and in Maryland an increasingly large proportion is from private beds—a condition which 25 years ago would have been regarded as almost impossible, for at that time these States were firmly committed to the policy of making their oyster industry depend on public or natural beds and restrictive measures, and discouraged the general inauguration of oyster planting on public oyster grounds.

OYSTER CULTURE IN THE UNITED STATES

This policy was in strong contrast with that in the next most important oyster-producing region, namely, Long Island Sound, where the States of New York and Connecticut had cut loose from the old fetish of the sanctity of public oyster grounds, had leased or sold those grounds for planting purposes, and had assumed the front rank, although their natural advantages for oyster growing were much inferior to those in Chesapeake Bay.

The rank early attained by the United States in the oyster industry was due to the great area of the oyster-beds; but the maintenance of that rank depends on the general adoption of oyster culture as the only certain means of insuring a

yearly increasing crop that will keep pace with the increasing demand.

Of the oysters marketed last year, 50 per cent came from private or cultivated grounds. Owing, however, to the improvement in the quality and shape of oysters by cultivation, the product of the private beds represented 70 per cent of the total value of the yield of market oysters. While the quantity of oysters taken from cultivated grounds in the United States is larger than in all the remainder of the world, yet the proportion of such oysters to the total output is much smaller than in any other important oyster-producing country.

Wherever the fishery is active and the demand great, the necessity for artificial measures to maintain the supply sooner or later becomes manifest. Some of the States long since ceased to place reliance on natural beds as sources of supply, and encouraged oyster culture by leasing or selling all available grounds to prospective oyster farmers, and each year other States are falling in line for progressive methods.

The American oyster industry has been greatly retarded in one of the most important regions by the failure of the States to adapt themselves to existing conditions and by their deep-seated prejudice against innovations based on modern conceptions and experience.

Nowhere in this country is there any excuse for continuing to rely on public oyster grounds as sources of supply, and the proposition to discourage or prohibit individual control of land for agricultural purposes would not be less absurd than to prevent or retard the acquisition of submerged lands for aquicultural purposes.

The prosperous condition of our oyster industry at present is directly due to the more general acceptance of more rational



Photograph from Dr. Hugh M. Smith

OYSTERS GROWING WITHIN AND ON A YEAST-POWDER BOTTLE

In America and England the general practice is to use old oyster-shells as cultch, but in France and Holland the spat is generally collected on concave earthenware tiles. It is necessary to detach the oysters from the tiles before they are a year old, and, as this could not be done without injury were the young directly attached to the hard tile, a coating of lime or soft mortar is used to cover the tile, and from it the oysters can be easily removed with a sharp knife.

standards as regards oyster culture, and it is only a question of a few years when there will be unanimous recognition, as an orthodox fact, of what a short time ago would have been regarded as the rankest economic heresy, namely, that natural oyster-beds as a general proposition are to be considered nuisances, whose perpetuation delays progress and impairs the prosperity of the oyster industry.



Photograph from Dr. Hugh M. Smith

AN OYSTER STOCKADE IN SAN FRANCISCO BAY

“The grounds are surrounded by stockades, principally for the purpose of protecting the beds from the inroads of strong-jawed sting-rays, which at times enter San Francisco Bay in schools, and would crush and devour large quantities of marketable oysters unless excluded by the stockades. Within the inclosures the planting, transplanting, growing, gathering, and culling are done under ideal conditions.” (See page 223.)



Photograph from Dr. Hugh M. Smith

THE OYSTER FLEET LYING OFF BALTIMORE

Baltimore is the chief point of distribution for the oysters produced in Chesapeake Bay, which is the greatest oyster ground in the world. Baltimore is also one of the great centers of the oyster canning industry. Oysters were first canned at Baltimore in 1820 by a certain Thomas Kennett, but it was not until 1850 that oyster canning became a distinct and permanent industry. Until 1900 Baltimore held the undisputed control of this industry, but since that time other canneries have been opened in the South. The expression "cove oyster," which now seems synonymous with canned oysters, was originally given to the small oysters found in the coves on the west bank of Chesapeake Bay between Baltimore and the mouth of the Potomac.



Photograph by Keystone View Co.

A MOUNTAIN OF OYSTER SHELLS READY FOR PLANTING: OYSTER CULTURE, HAMPTON, VIRGINIA

An essential of oyster farming is to spread on the bottom clear material for the attachment and temporary support of the young oysters. When first hatched, they are free-swimming, microscopic creatures, but in a few hours they fall to the bottom and are lost unless they can adhere to a firm, clean surface while making their shells and undergoing development.

SEVEN POINTS OF OYSTER CULTURE

Reduced to its simplest terms, oyster culture in the United States consists in (1) acquiring suitable submerged bottom, (2) cleaning and preparing that bottom for the growth of oysters, (3) sowing thereon shells or other material ("cultch") for the attachment and growth of the young oysters, (4) insur-

ing the production of larval oysters by the proximity of natural or planted beds of adult oysters, (5) protecting the oyster beds from enemies, (6) transplanting as occasion requires to prevent overcrowding and to facilitate growth and fattening, and (7) culling and sorting for market.

A prevalent practice among oyster

growers in some sections is to transfer oysters from salt water to brackish or less dense water for a short time before shipping to market, with the object of making them take on an illusive appearance of fatness by the rapid absorption of fresher water, while the more saline fluids in the tissues slowly pass out. This process, known as plumping, floating, or fattening, results in a swelling of the oysters to the full capacity of the shell, but adds nothing to their nutritive value or flavor. On the contrary, it extracts certain nutritious ingredients and replaces them with water. Chemical tests have shown that this sadly misnamed process of "fattening" deprives the oysters of 10 to 15 per cent of their food value, while increasing their weight from 10 to 20 per cent. A similar result is seen when oysters are placed in fresh water or brought into contact with melting ice after removal from the shell.

OYSTERS ON THE PACIFIC COAST

More serious, however, than the loss of nutritive properties is the danger from contamination by pathogenic bacteria when the floats are situated within the range of sewers or other sources of pollution. It is well known that oysters imbibe disease germs with their food, and such germs may be taken into the human body with their vitality unimpaired and give rise to sickness. Epidemics of typhoid fever have been definitely traced to "floated" oysters which were undoubtedly innocuous when taken from the saltier water.

It will thus be seen that this feature of oyster growing is not commendable, and is necessarily prejudicial to the best interest of the industry. The growth of the practice has been due to the ignorance of the public; its continuance after its undesirable nature has frequently been shown is a sad commentary on our intelligence.

While the entire east coast of North America has but a single species of oyster, the Pacific coast has five or six native species, and has been further enriched by the one from the Atlantic.

The most abundant of the native species, found in all the Pacific States, is very small and has a strong flavor. It is never served on the half shell, but is

eaten in bulk, one hundred or more oysters often being a "portion" for one person. The largest and best occur in Willapa Bay, Washington.

During the past 40 years immense quantities of Atlantic oysters have been transplanted to the Pacific coast, and a large business has sprung up which surpasses that in the natives. It is necessary, however, to renew the supply annually, particularly in Oregon and Washington, where the water is of too low a temperature to permit the eggs of the transplanted oysters to develop. This difficulty may eventually be overcome, and an oyster fully equal to that of the Atlantic may be produced by the acclimatization from the coast of Japan of a large oyster that is able to spawn in relatively cold water. Experiments to this end have been undertaken with promising results.

In the warmer water of San Francisco Bay the conditions for oyster culture are different, and there a very extensive and peculiar kind of oyster farming has sprung up. The grounds are surrounded by stockades, principally for the purpose of protecting the beds from the inroads of strong-jawed sting-rays, which at times enter San Francisco Bay in schools, and would crush and devour large quantities of marketable oysters unless excluded by the stockades. Within the inclosures the planting, transplanting, growing, gathering, and culling are done under ideal conditions.

A large oyster, similar to our Atlantic species, grows in great abundance in the Gulf of California, and is eaten in limited quantities in the adjacent parts of Mexico. The grounds are virgin, and are capable of supporting a large industry.

HOW OUR GOVERNMENT AIDS THE OYSTER FARMERS

The Federal government, as represented by the Bureau of Fisheries, does not hatch oysters artificially and distribute them by the billion for the stocking of public and private waters as it does food fishes. A much more potent way to increase the oyster supply is the one that has been followed for many years, to the entire satisfaction of the oyster-growing communities.

This consists in practical aid to the States and coöperation with them in de-

termining the physical and biological characters of the oyster grounds, in surveying and plotting those grounds with a view to their allotment for oyster culture, in conducting experimental and model planting operations, in recommending oyster legislation, and in giving disinterested expert advice on the various problems that arise in the development and administration of the oyster fishery.

Assistance of this kind has been rendered to every coastal State, and official requests for additional aid have been so numerous that the facilities of the Bureau of Fisheries have been overtaxed with respect to both funds and trained men for the work. The most recent surveys, experiments, and inquiries have been in Connecticut, New York, Delaware, Maryland, Virginia, Alabama, Mississippi, Louisiana, and Texas, in several of which States the Bureau of Fisheries and the Coast and Geodetic Survey have joined forces in the accomplishment of special plans.

The beneficial results of the government's efforts in behalf of the oyster industry of the various States have been conspicuous and lasting. The recent remarkable increase of the oyster output in the Gulf States is directly attributable to those efforts. In Long Island Sound recent experiments by the United States Bureau of Fisheries in the artificial propagation of the oyster have given promising results.

Especially noteworthy has been the

outcome of certain experimental planting operations in Louisiana. In Barataria Bay, where there had previously been no oyster industry, experimental beds laid out by experts of the Bureau of Fisheries yielded marketable oysters at the extraordinary rate of 1,500 to 2,000 bushels per acre in two years from the time the cultch was deposited on barren bottom. The natural consequence has been that all available oyster-growing land has been leased by the State, and a great impetus has been given to oyster culture.

The oysters thus produced on bottoms never before utilized are of high quality and meet with ready sale in New Orleans, where the "raccoon" and other oysters from the natural beds can hardly be sold at one-fourth the price.

In further pursuance of its paternal policy of promoting the oyster industry, the Bureau of Fisheries has sought to make known to fishermen, State officials, and legislatures the methods and conditions of oyster fishing and oyster culture in all parts of the world. To this end inquiries have been made in all foreign countries having important oyster resources. Special reports thereon have been issued and distributed broadcast, and, so far as its powers and facilities have permitted, the government has applied the knowledge gained abroad and at home to the particular requirements of the individual States in pointing out the way for the most successful utilization of the oyster grounds.



Life on the Grand Banks

An Account of the Sailor-Fishermen Who Harvest the Shoal Waters of North America's Eastern Coasts

By FREDERICK WILLIAM WALLACE

With Illustrations from Photographs by the Author

IT HAD been blowing a hard December gale for two days and the big liner was rolling and pitching enough to interfere with the comfort and equanimity of the thousand or more passengers aboard her. The few hardy ones who appeared at table bragged of their performance in lounge and smoking-room and opined it was quite a storm; the vast number of the prostrate vowed it was a hurricane.

In the lift of a squall of snow some one, peering through the great windows of the lounge, declared he saw a ship, a small schooner, close alongside. A rush was made for hats and wraps and the small party of those whom seasickness did not claim ventured out on the wind-and-spray-swept promenade deck to view the tiny craft which had the temerity to brave such winter weather so many miles offshore.

The writer happened to be coming home from Havre, and one glance at the schooner to windward served to recognize an old friend. She was a Banks fisherman, from Gloucester or Lunenburg possibly, and she was bound west for home, under heavy-weather canvas.

A GLIMPSE IN THE GALE

Passing within a cable's length of our rolling and wallowing leviathan, the little 100-ton schooner was storming along with a broil of white water shearing away from her sharp, round stem, and her reefed sails were as stiff and as white as marble, in the weight of the gale.

She would top a mighty Western Ocean gray-back with the graceful spring of a steeple-chaser, bowsprit pointing to the gray skies and red-painted underbody showing clean to the heel of the foremast; then with an easy plunge, like a porpoise diving, she leaped over the cresting surge

and drove down into the trough with but the masts and upper parts of the sails showing above the bluey-green of the combers.

"They're *sailors* aboard that craft," observed a business man to the grizzled chief officer, who had been cajoled from his watch below by the sight.

"Aye," he returned slowly, "they're sailors all right. She's an American fisherman homeward bound." And he stared at her for a minute or two, until she vanished in a flurry of snow.

WHAT THE SEAMAN MEANS BY "SAILOR"

In this age of steel hulls and steam and motor propulsion, the term "sailor" is often misapplied. All who are employed at sea on board a ship are called "sailors" by landsmen, but seamen narrow the embrace of the term down to those who can steer, equip, repair, and handle the canvas of a sailing craft under sea conditions. All others are deck-hands and seamen.

Sailors of the orthodox class even go a step further and designate all the personnel of a steamer as "steamboat-men." They consider the terms "seamen" and "sailor" to be sacred to ships driven by wind and canvas.

It has been my privilege to sail and steam the oceans in many kinds of craft, ranging from the romantic full-rigged clipper ship to the oil-burning greyhounds of twenty-knots speed, and from the graceful, sea-kindly Grand Banks fishing schooner to the sturdy steam-trawler of North Sea type; but in all my voyaging I am inclined to the belief that the only real "sailors" we have today, in this mechanical age, are to be found in the Banks fishermen of North America's Atlantic coasts.



SIXTEEN KNOTS IN A DECEMBER BLOW

The photograph was taken from the bowsprit of an American fishing-schooner a few moments before it became imperative to reduce sail.



Photograph from Phelps Studio

IN THE HARBOR AT GLOUCESTER

Within a few years after the landing of the Pilgrim Fathers, Gloucester had become the pioneer fishing port of the New World and a “nursery” for stalwart seamen of the American Navy—the men whose descendants were to make history under such leaders as John Paul Jones, Perry, Lawrence, Bainbridge, and Decatur.



A BIG FELLOW: A GULF OF ST. LAWRENCE HALIBUT
WEIGHING ABOUT 300 POUNDS

The sailors I refer to are the crews of the beautiful fishing schooners that sail out of the fishing ports of Newfoundland, the Maritime Provinces of Canada, and the New England States of America; and the ports which claim most of them are Lunenburg, in Nova Scotia, and Gloucester and Boston, in Massachusetts.

THE SEA IS BEFORE HIS EYES
FROM INFANCY

Physically, your American deep-sea fishermen are strong-muscled and able to endure hardship. They are not slum or city products, but are mainly raised in sea-coast villages of the Canadian provinces and Newfoundland.

At an early age they learn to handle

an axe, to work on the land, and to rig and bait fishing gear. In the summer months the boys usually go shore-fishing or lobster-trapping. The sea is before their eyes from infancy; the roar of it in their ears and the smell of it in their nostrils.

At sea the Banks fisherman manifests his distinctiveness, and the splendid inherited qualities of the type are seen to advantage—daring, initiative, skill in seamanship, and ability to endure long hours of heavy labor and the rigors of seafaring in small vessels during the varying conditions of weather on the North Atlantic.

It may be said that he is no different from the European fisherman in this respect; but comparisons will show considerable differences. The deep-sea fisherman of Europe has practically outgrown sail, and works on powerful steam-trawlers, where ability to run a winch, haul and heave a trawl-net, use a netting needle, and dress and box fish are practically all that is required of him. On the few sailing smacks operating nowadays in European waters the trawl-net is also used as well as hook and line and drift-net. All the work is done on board the vessel.

In the North American fisheries the fast-sailing and seaworthy schooner still remains as the prime means of producing fish from the Western Atlantic "banks," and the greater part of the fishing is done from small boats, known as dories, which are carried by the schooner and launched upon the fishing grounds.

It is this dory fishing which makes the American fisherman, and by that term I include Canadian and Newfoundlander, a distinct type from his colleagues in other countries, and adds to his vocation a hazard and labor which calls for certain sterling qualities to surmount.

But while backward in changing over to steel and steam, our fishermen have



SPEEDING FOR MARKET: A BANKER IN WINTER RIG

The modern Banks fishing-schooners are undoubtedly the handsomest commercial sailing craft afloat. They are built of wood and range from 100 to 150 feet in length, with a tonnage of from 80 to 175 tons.

evolved a type of sailing schooner which is the last word in weatherly qualities and speed under sail, and the men who man these vessels are the only real sailors left in this age of steam.

THREE KINDS OF BANKS FISHERIES

There are three distinct fisheries in which the schooner fleets of the Western North Atlantic are employed, namely, fresh fishing, salt fishing, and halibut fishing. Mackerel seining also employs a schooner fleet during the season, but this is not a Banks fishery in the accepted sense of the term.

As most people know, the Banks are vast areas of shoal water lying at various distances off the eastern coasts of the United States and Canada and south and

east of Newfoundland. Upon these Banks, in depths ranging from 15 to 200 fathoms, tremendous numbers of certain demersal species of fish are to be found at various seasons. Cod is the commonest variety caught; Haddock ranks second, while Hake, Pollock, Cusk, Halibut, Skate, Whiting, Catfish, Wolf-fish, Monkfish, and Lumpfish are also marketed.

FISHING WITH A LINE NEARLY HALF A MILE LONG

In the offshore fisheries upon the Banks, none of these fish are caught by net unless by steam trawling. In the schooner fishery the long-line, misnamed "trawl" by fishermen, and hand-line are used exclusively.

The long-line is, as its name implies, a



A PEN OF CODFISH ON A SCHOONER'S DECK

At the end of the day in the dories the work of "dressing down" the catch begins.

long line, ranging from 2,100 to 2,400 feet in length, and is made of thin, but incredibly strong, tarred cotton.

Into this "back line," or "ground line," are spliced thinner lines, called "snoods" or "gangens," at thirty- to forty-inch intervals. These snoods are usually from twenty to thirty inches long, and a strong steel hook is bent to each. Thus, on each long-line there are from 600 to 800 snoods and hooks.

Each long-line is coiled down in a wooden tub—often made by the fishermen themselves by cutting down a flour barrel—and every hook has to be baited before the "gear" is set.

In halibut fishing a much heavier line and hook are used, and as the snoods are spliced or bent into the ground-line at lengthier intervals, there is consequently a lesser number of hooks affixed to a coil of halibut gear.

Halibut line is not coiled down in tubs, but secured, when not in use, by a small square of canvas from which four pieces of short rope depend. The coil is placed upon the canvas and the ropes are used to lash the gear up in a compact bundle, the whole being called by fishermen "a *skate* of halibut gear" in contra-

distinction to "a *tub* of cod or haddock trawl."

THE ACTUAL FISHING IS FROM THE DORIES

On every Banks fishing-schooner, except hand-liners, on which the fishing is done from the deck, a number of flat-bottomed, high-sided boats, called "dories," are carried. These dories are from 18 to 22 feet over all and their thwarts are removable, so as to permit their being "nested" one within the other upon the schooner's decks when not in use. From six to twelve of these dories are carried by fishing schooners, and it is from the dory that the actual fishing is done.

The modern Banks fishing-schooners are undoubtedly the handsomest commercial sailing craft afloat. They are built of wood and range from 100 to 150 feet in length, with a tonnage of from 80 to 175 tons. Their lines are fine and designed for speed, but weatherliness has been so well combined in the model that neither quality has been sacrificed. True, they are terrible craft for jumping about in a breeze and sea, but they seldom ship any heavy water on deck during a blow, unless "knocked down" or "tripped up" by squall or irregular wave.



MUZZLING A JIB IN A SQUALL

In winter weather, fishing can be carried on only in the lulls between squalls. At this season schooners are stripped for heavy weather, topmasts and light sails being left ashore.

Well-ballasted and drawing a lot of water aft, the Banks schooner stands up to a great spread of sail, the main-boom in some vessels being 75 feet long. The big mainsail is the largest piece of canvas on a fisherman and it is carried until the whole strength and skill of twenty to twenty-five men is required to make it fast in a strong breeze.

EVERY BANKS SCHOONER IS A SEAFARING DEMOCRACY

Every Banks fishing schooner is a sort of seafaring democracy. The crew works the ship on a coöperative basis, with the skipper as sailing and fishing "boss." In Canadian and American craft in which the writer sailed, the gang were shipped on the share system, their remuneration consisting of an equal share of the proceeds of the catch after the bills for victualing, ice, salt, bait, cook's wages, and other incidentals had been paid.

The schooner took a quarter or a fifth of the gross stock, and this repaid her owner for the hire of the vessel. Out of this share came the cost of insurance and upkeep, but in good seasons, prior to 1914, many schooners paid their cost of

construction within twelve months. In those days, however, a Banker could be built for \$12,000; nowadays they cost nearly \$50,000.

The share system has had many variants. Formerly, in some vessels, it was "even shares," where all hands drew the same amount. In other craft it was "by the count," where each dory kept count of the number of fish caught and the dory catching the greatest number drew the highest share. The lucky dory was known as the "high line" or "high dory"; the lowest count was "low dory," and in some ships if a pair of fishermen came "low dory" too often they were "fired."

Both of these systems had their drawbacks, and of late years so many new methods of dividing the proceeds of the catch have been instituted in the different vessel fisheries that it would be confusing, and possibly erroneous, to quote any one as being the standard.

I have been on voyages where the men drew \$70 each for a week's work, and on others where they made but \$45 in two months. The Goddess of Luck has something to do with the fisherman's remuneration, but the men who fish steadily



BAITING HALIBUT LINES WITH FRESH HERRING

There are three kinds of fisheries on the Banks—salt fishing, fresh fishing, and halibut fishing.

throughout the year with hard-working skippers usually make a good income, though it is never commensurate with the risks they take.

The crew, or "gang," of a Banker runs from sixteen to twenty-five men. A schooner "running ten dories" would have a crew sufficient to man ten dories with two fishermen in each. In addition to these twenty men, there are the skipper, the cook, a deck-hand, and, if the vessel is an auxiliary, an engineer. In some vessels neither deck-hand nor engineer is carried.

NO FAVORITES ON A BANKS SCHOONER

All navigating is done by the skipper. The men are primarily fishermen, but they are under the skipper's orders and must help to sail the vessel, to steer and keep a lookout, and to set and furl sail.

On passages to and from the Banks, the fishermen take regular turns in standing a watch at wheel and lookout. With a gang of twenty men and two men to a watch, this period is not a very long one, as a rule, but in bitter winter weather, with a hard breeze blowing, an hour at wheel and lookout is long enough. I have known times when ten minutes at the wheel required relief to thaw out fingers and toes numbed with zero frost.

When sail has to be set or made fast,

all hands are called. If the men are asleep and it is only a small job that requires four or five hands, the whole crowd is turned out to do it. By doing this, no favorites are made and no one can complain that he is being imposed upon. I have seen twenty men roused from slumber to take in a jib—a job three fellows could have done—and the skipper saw to it that no man loafed below.

During the run-off to the "grounds" the fishermen are busy overhauling their fishing gear. Each man has his dory-mate and his particular dory and they divide the work between them. It is incumbent upon them to have their lines in good shape and their dory properly equipped when the skipper sings out, "Bait up!", the schooner having reached the Bank to be fished.

THE SOUNDING LEAD IS THE SKIPPER'S OTHER EYE

Six to eight tubs, or skates, of gear have to be kept in order and baited by the two dory-mates—a task which calls for much skill and deftness of fingers, when some 2,000 hooks have to be baited with pieces of herring, squid, or capelin every time a "set" is made.

The passage to the Banks may be a run of from fifty to five hundred miles and it

is usually made in the quickest possible time.

When the vessel has run her distance, the "spot" the skipper has been making for is found by the lead. The sounding lead is a fishing skipper's other eye and he is usually an adept in determining his position by means of it.

While there are many fishing captains who can navigate by solar and stellar observations, yet the majority find their way about by dead-reckoning, using compass, chart, log, and lead, and their accuracy is often startling.

The sample of the bottom brought up by the soap or tallow on the lead and the depth of water give most skippers an exact position after two casts.

If the gear has been baited and the weather is favorable, the skipper sings out, "Dories over!" The dory-mates who hold the two top dories on the port and starboard "nests" prepare their boats for going overside by shipping the thwarts and jamming the bottom-plugs in.

Oars, pen-boards, bailer, water-jar, bait-knife, gurdy-winch, bucket, gaff, sail and mast, and all other boat and fishing impedimenta are placed in each little craft, and it is swung up out of the nest and overside by means of tackles depending from the fore and main shrouds.

SETTING THE LINES

Two fishermen secure their tubs of baited lines and jump into the dory, which is allowed to drift astern. The painter is made fast to a pin in the schooner's taffrail and the dory is towed along by the schooner. As the other dories are launched, they are dropped astern, made fast to each other, and towed by the schooner.

When all the dories are overside, the skipper, at the wheel of the schooner, determines the direction in which he wants to set his lines, and the dories are let go, one at a time, as the vessel sails along. A schooner "running" ten dories will have them distributed at equal distances along a four or five-mile line and Number One dory is often out of sight from the position of Number Ten.

When the last dory has been dropped, the skipper will either "jog" down the line again or remain hove-to in the vicinity of the weather dory while the men are fishing.



A TYPICAL FISHING VESSEL SKIPPER

In the dories, when the schooner has let them go, one fisherman ships the oars and pulls the boat in the direction given him by the skipper, while the other prepares the gear for "setting."

The end line of the first "tub" of baited long-line is made fast to a light iron anchor to which a stout line and buoy-keg is attached. This is thrown over into the water, and the fisherman, standing up in the stern of the dory with the tub of long-line before him, proceeds to heave the baited gear into the sea by means of a short stick which he holds in his right hand.

BAITED LINES OVERBOARD

With this "heaving stick" he dexterously whirls the coils of line and hooks out of the tub and the long-line goes to the sea-bottom.

Three or four tubs, the lines joined together, may be set in this fashion, and another anchor and buoy is made fast to the last end. The long-line now lies on the bottom of the sea and is prevented from drifting or snarling up in bottom or tidal currents by the anchors at each end.

The fishermen in the dory hang on to the last anchor until it is time to haul the gear, or they may leave it altogether and



“FLYING SETS” ON THE BANKS

The dories are being towed by the schooner. The black disks are “high-flyers,” or “black-balls,” which are affixed to the buoys attached to the fishing lines, as markers.

pull back aboard the schooner again, leaving the location of their lines to be marked by a flag or "black-ball" thrust into the buoy-keg attached to the anchors at each end.

The lines may be "set" for periods varying from thirty minutes to half a day. In the latter case the fishermen will be towed back to their gear again by the schooner and cast adrift when the buoys marking their respective lines appear in sight.

The picking up of these tiny buoys and flags, scattered over five or six miles of ocean, is quite a knack, and the fishing skippers seem to possess an uncanny sense of location in finding them. The writer has known schooners being forced to leave their gear in the water and run to port for shelter in gales of wind, and to return two or three days afterward and pick it up again without much trouble.

When ready to haul the long-line, the fishermen insert a *lignum-vitæ* roller in the gunwale of the dory and pull the anchor and buoy up.

The end of the line fast to the anchor is detached and the fisherman, standing in the bow of the dory, commences to haul the long-line out of the water. His dory-mate stands immediately behind, and as the line comes in it is his job to coil it back into the tub again after knocking off the untouched bait.

A VOLLEY OF "SLATS" MEANS POOR HAULS

The fisherman hauling the line over the roller disengages the caught fish by a dexterous twist of the arm. This back-handed jerk whips the hook out of the jaws of the fish and it flops into the bottom of the dory. Fish which cannot be cleared in this manner are passed on to the man at the tub, who twists the hook out by taking a few turns of the snood around the "gob stick," which he thrusts into the mouth of the fish.

Unmarketable species—Sculpins, Skate, Dogfish, etc.—are knocked off into the sea by a vicious slat against the dory gunwale. On a quiet summer's day there is no more disheartening sound to a fishing skipper than to hear a continuous volley of "slats" coming from the line of dories. It means that the Dogfish are swarming on the grounds, and that they

have taken the hooks intended for better fish.

When the lines have been hauled and the last anchor is up, the fishermen row or sail down to the schooner, which is generally hovering around like a hen keeping guard over her chickens. The dory rounds up alongside the vessel, the painter is caught by some one aboard her, and, after handing up their tubs of long-lines, the two fishermen pitch out their fish upon the schooner's decks.

Certain sections of the deck have been penned off for the reception of the catch, which prevents the fish from sliding to leeward when the schooner rolls.

THE JOB OF DRESSING DOWN THE CATCH

At the end of the day, when all hands are aboard, the work of "dressing down" the catch commences. The fish are split and gutted, and some species are beheaded, by the fishermen, standing at tables rigged up on deck. The dressed fish are then washed in tubs of salt water and consigned to the hold, where they are packed away on chopped ice.

If the vessel is salt-fishing, the fish are piled upon each other in the hold-pens and liberally covered with coarse salt.

After the catch has been cleaned and stowed away, the men bait up their gear for the morrow's "set." If the fish are biting freely and the catch is heavy, the fisherman's day is a long one. Dories will often be swung overside before sunrise and the men will finish by midnight.

There is very little sleep to be got on the Banks when the weather is fine and the vessel is "on fish," and the writer remembers one occasion in winter fishing on a market fisherman when the gang were kept hard at it from Sunday night to Thursday morning with but an hour's sleep each night. On Thursday a gale of wind came along and it was hailed with pleasure, as an opportunity to "lay off" and catch up on slumber.

SUMMER FOG WORST ENEMY

The foregoing description is that of the life on a market or fresh-fishing schooner running her catches to port for consumption in a fresh or smoked state.

The "marketmen" seldom remain at sea longer than ten days, but life aboard these craft demands the greatest skill and hardihood on the part of skipper and



REPAIRING A TORN SAIL

crew. They waste no time in getting to the fishing Banks, and usually go tearing out under a press of sail. Dories are hoisted over before dawn, and the men often fish all night, with torches aflame on the dory gunwales. They will go over-side in pretty rough weather and will remain out until the last minute, in the face of fogs and squalls.

In summer, fog is the fisherman's worst enemy. Dories may be strung out when it is fine and clear, and before they can be picked up again they are blanketed from view in a wet, sight-defying mist.

The skippers are wonderfully clever at locating the hidden dories, but it often happens that some cannot be found, and their names are listed with the yearly death toll of the Banks.

But there are not many casualties, considering the frequency of the fogs, and I can remember one occasion when 56 dories were reported astray from their vessels and all were either picked up by other schooners or else rowed in from the Banks to the land. Some of the distances stray fishermen have rowed in dories seem incredible, but a pull of 150 to 175 miles in rough weather and without food is not an unusual accomplishment.

A few years ago, during April, two fishermen got astray from their vessel on Quero Bank and were picked up *fourteen days* afterward 30 miles northwest of St. Pierre. They had but a little cake and some water to sustain them during that period and only managed to keep from freezing to death by constant rowing. One man's feet and hands were black from frostbite when picked up.

THE SIREN STRIKES TERROR

Fog inspires fear in fishermen by reason of the danger of being run down by steamers. Many schooners have been sent to the bottom thus, and the roar of a steamer's siren close aboard in foggy weather will have a crowd of fishermen out of their bunks quicker than anything else I know of.

The living quarters in fishing-schooners are in forecastle and cabin. These apartments are lined with bunks—possibly sixteen single bunks forward and four to six double bunks aft.

The galley is located in the after part of the forecastle and the mess-table is fitted between the foremast and the windlass-pawl-post. All hands eat their meals in the forecastle.



“ALL HANDS TO THE MAIN-SHEET”

The fishermen practically live in oilskins and rubber boots while at sea.



A NEST OF DORIES AND BULWARKS COVERED WITH ICE

The skipper lives aft, in the cabin. In some schooners he has a little room to himself, but in a good many he sleeps in an open bunk like the fishermen. The galley stove keeps the forecastle warm, and a small "bogey," or base-burner, heats the cabin.

As fishermen are constantly wet, the stoves are kept continually fired to dry out sodden clothing.

Though it is a hard, cold, and hazardous existence, yet the fishermen's life has some compensations. The cooks carried

are masters of the culinary art and the meals provided are of the most luxurious description. All the staples and all the luxuries go aboard a fishing vessel, and the scale of victualing is Biltmore style without the silver and cut-glass.

A fisherman is always hungry, and in addition to three square meals per diem, he indulges in a "mug-up" between times from the "shack locker," or quick-lunch cupboard in the forecastle. Tea and coffee are always on the stove.

With stoves going below, it is always warm and pleasant in cabin and forecastle, and a fisherman's bunk, with a good thick quilt or blanket and a straw mattress, makes a snug sleeping place. One never sheds many clothes on retiring; the discarding of boots and jacket is enough.

The cabins and forecastles are clean and well kept. Vermin is a fisherman's horror, and the writer has known men of questionable cleanliness to be sent ashore.

THE RACE TO MARKET

A smart vessel is a fisherman's pride, and he will never lose an opportunity to try her out against other craft. Your fisherman is a sail-dragger. He believes in carrying his canvas to the last minute, just for the fun of seeing her go. To be one of a fleet of Banksmen "swinging off" for market in a stiff breeze is to confirm one in the belief that the American fisherman is the finest sailor of the present day.

INDEX

Extensive biographies and color plates of fishes are listed also in
front pages of The Book of Fishes

A

	Page
Age of fish, Scales show.....	90-91, 93, ill. 81
Alaska, Salmon fisheries of.....	199, 202, 205, 209, 210, 211
Albacore, Great, Tuna known as.....	33
Alewife (<i>Pomolobus pseudoharengus</i>).....	5, 27, 60-61, (color plate) 47
Alligator Gar.....	(legend) 106
Allison, James A.....	189, 194
Allison's Tuna (<i>Thunnus allisoni</i>).....	140, 142
Amber Jack (<i>Seriola dumerili</i>).....	140, 183, ill. 185, 188, (color plate) 155
American Lobster (<i>Homarus americanus</i>).....	15, 16, 17, 19, 21, 67, 69, 159, (color plate) 54
American Museum of Natural History, New York City....	19
Amia lives in West Indian Conch.....	130
Anatomy of the oyster.....	ill. 214
Anadromous fishes.....	5, 23
Anchovies, Schools of.....	162
Anemones on ocean floor.....	ill. 138, 171
Angel-Fish.....	(color plate) 176
Angel-Fish, Blue (<i>Angelichthys isabelita</i>).....	163, 164, (color plate) 176
Annelida, Tube-forming.....	19
<i>L'Apache</i> , Sea-going motor yacht.....	189
Arkansas, Fishing in.....	ill. 108
Artificial propagation of fishes.....	25, 205, ill. 34, 91, 107
Atlantic Highlands.....	19
Atlantic Salmon (<i>Salmo Salar</i>)... 5, 8, 23, 24, 25, 29, 30, 63, 91,	(color plate) 50
Australian Lung-fish.....	90
Avernus, Lake, Oyster cultivation at.....	(legend) 218

B

Bahama Islands.....	142, 151, 162, 189
Bainbridge, William.....	(legend) 227
Baird Piscicultural Preserve.....	205
Bait.....	35-36, 37, 88, 235, ill. 78, 232
Balmoral Cannery, Skeena River, B. C.....	ill. 207
Baltimore, Oyster fleet lying off.....	ill. 221
Banks, The.....	1, 9, 36, 195, 225, 229, 232, 235, 236
Barataria Bay, La.....	224
Barbour.....	30
Barnacles (<i>Balanus</i>).....	19, 217, ill. 129
Barnegat Bay, N. J.....	ill. 70
Barracuda (<i>Sphyraena barracuda</i>).....	134, 137, 139, 167, 170, ill. 168, (color plate) 143
Bass, Black.....	89, 95, (color plate) 112
Bass, Black Sea.....	31
Bass, Calico (<i>Pomoxis sparoides</i>).....	90, 96, ill. 102, (color plate) 114
Bass, Cannibal.....	ill. 84
Bass, Channel.....	ill. 32
Bass family.....	25, 77, 89, ill. 84
Bass, Large-mouth Black (<i>Micropterus salmoides</i>).....	90, 95, ill. 84, (color plate) 112
Bass, Rock (<i>Ambloplites rupestris</i>).....	89, 90, 95-96, ill. 101, (color plate) 113
Bass, Sea (<i>Centropistes striatus</i>)... 37, 70, 164, (color plate) 73	
Bass, Small-mouth Black (<i>Micropterus dolomieu</i>)... 95, ill. 87,	(color plate) 112
Bass, Striped (<i>Roccus lineatus</i>).....	5, 24, 31, 35, 36, 69-70, 90, (color plate) 72
Batchelder, A. G.....	189
Bay of Florida.....	183
Beau Gregorys.....	183
Bermuda Islands.....	5, 139, 140, 175
Bigelow, R. P.....	30
Bimini, Bahama Is.....	189, 191, 193, 194, ill. 192
Black Angel-Fish (<i>Pomacanthus arcuatus</i>).....	(color plate) 176
Black Bass.....	89, 95, ill. 92, (color plate) 112
Black Drum, destructive to oysters.....	216
Black Grouper (<i>Mycteroperca bonaci</i>).... 139, (color plate) 146	
Black Sea Bass.....	31
Black-tip Shark (<i>Carcharhinus limbatus</i>).....	183
Blessing the fish on the sea, London.....	ill. 6
Blue Angel-Fish (<i>Angelichthys isabelita</i>).....	163, 164, (color plate) 176
Blue-cheeked Sunfish.....	89
Blue Sharks.....	174
Blue Striped Grunt (<i>Haemulon sciurus</i>).....	185, ill. 132, (color plate) 181

Page

Blueback Salmon.....	199, 200, 201
Bluefish (<i>Pomatomus saltatrix</i>).....	27, 31, 35-36, 70-71, 195, (color plate) 74
Boats, Fishing.....	ill. 16, 18, 20, 26, 28, 33, 34, 58, 60, 64, 66, 70, 90, 108, 136, 137, 161, 185, 197, 221, 222, 226-234, 237, 238
Bonefish (<i>Albula vulpes</i>).....	131, 135-136, (color plate) 151
Bonito (<i>Sarda sarda</i>).....	27, 71, 174, (color plate) 74
Boston, Mass.....	27, 29, 127, 228, ill. 3, 16, 28
Boston State House, The "Sacred Codfish" in.....	195, ill. 3
Bottle, Oysters growing within a yeast-powder.....	ill. 219
Boulanger, G. A.....	90
Bowfin, Mudfish or.....	89, 90
Branch Herring.....	5
Brazil, Coast of.....	142, 163
Bream a fish-eating fish.....	89
Breathing apparatus of fish.....	11, 13
Breeding.....	13, 15, 133, 139, 199
Brighton Aquarium, England.....	90
Brook Trout (<i>Salvelinus fontinalis</i>).....	97, 99, ill. 98, (color plate) 116
Brown Shark (<i>Carcharhinus milberti</i>).....	183
Bryozoa, Lacelike.....	19
Buffalo-fishes.....	88, 195
Buffalo Trunkfish (<i>Lactophrys trigonus</i>).....	166-167, (color plate) 179
Bullhead, Common (<i>Ameiurus nebulosus</i>).....	93, 95, (color plate) 111
Burbot a fish-eating fish.....	89
Bureau of Fisheries, United States, Work of.....	9, 11, 19, 25, 30, 79, 84, 203, 205, 210, 211, 223, 224, ill. 26, 34, 91
Butter-fish (<i>Poronotus triacanthus</i>).....	27, 61, 63, (color plate) 49
Butterfly Fish (<i>Chaetodon ocellatus</i>).....	132, 163, 164, (color plate) 177
Buzzards Bay, Mass.....	9

C

Calico Bass (<i>Pomoxis sparoides</i>).....	90, 96, ill. 102, (color plate) 114
California Flying Fish.....	35
Camouflage among fishes.....	15, 130, 163, 173-174, 183, 184
Canal, Jumna: India.....	(legend) 160
Cannibal Bass.....	ill. 84
Canning lobster meat.....	ill. 13
Canning Salmon.....	ill. 208
Canoe, Indian fishing from a.....	ill. 82
Canon City, Colo., oldest fish remains from.....	27
Cans of young trout for planting in a Colorado Lake... ill. 107	
Cape Breton, Nova Scotia, waters, Fish from.....	ill. 33, 66
Capelin, Fishwives beheading: Island of St. Pierre.....	ill. 36
Carangiidae, or Crevally family.....	170
Carp a plant-eating fish.....	89, 90
Catfish.....	5, 11, 77, 93, 95, 137, 195, 229, ill. 108, 160, (color plate) 111
Catfish, Spotted (<i>Ictalurus punctatus</i>)... 93, 95, (color plate) 111	
Caviar, The source of.....	ill. 15
Cazadero Dam, Columbia River, Ore.....	ill. 203, 210
Cephalopods, highest class of molusca.....	187
CERTAIN CITIZENS OF THE WARM SEA. By Louis L. Mowbray.....	127
Channel Bass.....	ill. 32
Channel Catfish.....	89
Charlevoix, Mich.....	ill. 90
Chesapeake Bay.....	9, 218, 221, ill. 56
Chestertown, N. Y., Perch from.....	ill. 96
Children as fishermen.....	ill. 14, 70, 78, 97, 105, 140
Chinook Salmon.....	5, 195, ill. 196, 201
Chubs a fish food.....	77
Clams used as bait.....	37
Cleaning fish, St. John's, Newfoundland.....	ill. 17
"Cochina" nickname for Queen Trigger-Fish.....	(legend) 179
Codfish (<i>Gadus callarias</i>).... 7, 8, 9, 17, 19, 27, 38, 229, ill. 230,	(color plate) 39
"Codfish, Sacred," in the Boston State House.....	195, ill. 3
Coho or Silver Salmon.....	199
Colorado Lake, Cans of trout for planting in a.....	ill. 107
Columbia River, Ore.....	5, 199, ill. 203, 210
Common Bullhead (<i>Ameiurus nebulosus</i>).....	93, 95, (color plate) 111

	Page
Common Eel (<i>Anguilla rostrata</i>).....	5, 8, 35, 77, 109-110, (color plate) 126
Common Grunt.....	185
Common Squeteague (<i>Cynoscion regalis</i>).....	9, 24, 27, 31, 35, 69, 195, ill. 70, (color plate) 72
Common Sturgeon (<i>Acipenser sturio</i>).....	5, 7, 55-56, 77, (color plate) 42
Common Whitefish (<i>Coregonus clupeiformia</i>).....	77, 90, 93, 106-107, 195, (color plate) 122
Conch shell.....	17, 130-131, 191, ill. 138
Conger Eel.....	7, 8
Connecticut River.....	24
Cooking fish in hot-water hole.....	ill. 79
Coral reefs.....	130, 139, 164
"Cove Oyster," Origin of name.....	(legend) 221
Cow Pilot or Sergeant Major (<i>Abudefduf saxatilis</i>).....	164, 183, 184, (color plate) 182
Cowfish (<i>Lactophrys tricornis</i>).....	167, (color plate) 179
Crab discarding shell.....	ill. 22
Crabs as bait.....	35, 36, 37, 174
Crappie (<i>Pomoxis annularis</i>).....	89, 96, (color plate) 114
Crater Lake, Crater Lake National Park, Ore.....	ill. 85
Crawfish or Spiny Lobster (<i>Panulirus argus</i>).....	159, (color plate) 153
Crayfish part of food supply.....	81, 88, 89
Crevally family or Carangiidae.....	170
Croakers part of food supply.....	27
Crustaceans as fish food.....	19, 89, 159, 217, ill. 129
Cuba, Island of.....	167, 179
Cuckold (<i>Lactophrys triqueter</i>).....	167, (color plate) 170
CURIOUS INHABITANTS OF THE GULF STREAM. By Dr. John T. Nichols.....	163
Cusk (<i>Brosmus brosme</i>).....	27, 56, 229, (color plate) 43
Customhouse Tower, Boston.....	ill. 16
Cutthroat Trout.....	(legend) 97

D

Darters are food for fish.....	77, 98
Decatur, Stephen.....	(legend) 227
Delaware Bay.....	9, 24, 27
Delaware River, N. J., fisheries.....	1
Delaware River, N. J., Sturgeons from the.....	ill. 10
Denver, Colo.....	29
Desmarest.....	90
Devil-fish (<i>Manta birostris</i>).....	187, 193, 194, ill. 186, 190, 192
DEVIL-FISHING IN THE GULF STREAM. By John Oliver La Gorce.....	187
Digby, Nova Scotia: Drying fish at.....	ill. 9
Dimock, Messrs. A. W. and Julian A.....	(legend) 128
Dog, or Chum Salmon.....	199
Dog Salmon, Magnified scale to show age of.....	ill. 81
Dogfish, unmarketable fish.....	137, 235
Dolphin (<i>Coryphaena hippurus</i>).....	135, 140, 174, (color plate) 150
Dories.....	230, 231, 232, 233, 235, 236, ill. 234, 238
"Dressing down" the catch.....	235, ill. 230
Drum, Fresh-water (<i>Aplodinotus grunniens</i>).....	89, 107, 109, (color plate) 123
"Drummer" Weakfish, or Squeteague called.....	35
Drying fish at Digby, Nova Scotia.....	ill. 9
Drying nets near the Virginia capes.....	ill. 62

E

East River, N. Y.....	24
Eastern Pickerel (<i>Esox reticulatus</i>).....	31, 100-101, (color plate) 119
Eel, Common (<i>Anguilla rostrata</i>).....	5, 8, 35, 77, 109-110, (color plate) 126
Eel, Conger.....	7, 8
Eel, European.....	5, 90
Eels, spawning habits.....	5, 126
Eggs and milt removed from fish for artificial propagation.....	205, ill. 34, 211
Eggs, Fish.....	7, 8, 130, 131, 174, 202, 205, 208, 209, ill. 200
Eggs, Salmon, ready for shipment.....	ill. 200
Eigermann, C. H.....	30
Elver, European.....	5, 110, 126
Enemies of fishes.....	7, 8
Entomostraca, Minute.....	89
European Eel.....	5, 90
European Elver.....	5, 110, 126
European Trout.....	90
Evermann, B. W.....	30
Eyes, Why fish have spherical.....	11

F

Fauna, Marine and land, compared.....	22-23
Feeding fish, Man.....	ill. 89
Fierasfer lives in the Sea-pudding.....	131
Fighting fish of Siam.....	15
Filefish, Flat-sided.....	166
Fish bitten in two by larger fish.....	127, ill. 134
Fish-eating fish.....	89, 183
Fish eating from man's hand.....	ill. 89

Fish hatchery experts removing eggs and milt from fishes.....	ill. 34
Fish ladder, Cazadero Dam, Columbia River.....	ill. 203
Fish scale, Magnified to show age.....	ill. 81
Fish scaling a seven-foot wall.....	ill. 160
Fisher, Carl G.....	194
Fisherman hauling in his net, A Nova Scotia.....	ill. 2
Fisherman mending his nets, An Atlantic.....	ill. 14
Fishermen.....	77, 195, 212, 228, 233, 235, 236, 238, ill. 10, 14, 15, 18, 20, 28, 31, 33, 58, 64, 66, 79, 80, 82, 83, 85, 86, 88, 90, 108, 134, 197, 228, 231, 232, 234, 237
Fishermen, Game.....	ill. 32, 137, 188, 190, 192
Fishwives of St. Pierre.....	ill. 36
Fisherwomen.....	ill. 70, 136
Fishery industries.....	27, 30, 77, 81, 228, 229, ill. 9, 10, 12, 13, 15, 16, 17, 18, 19, 23, 28, 30, 31, 36, 56, 57, 58, 64, 90, 197, 200, 201, 207, 208, 215, 221, 222, 226-234
FISHES AND FISHERIES OF OUR NORTH ATLANTIC SEA-BOARD. By John Oliver La Gorce.....	1
Fishing fleet near Customhouse Tower, Boston.....	ill. 16
"Fishing Rod" of Ojibway Indians.....	ill. 82
Fishing-schooners.....	230, 231, 236, ill. 226, 229, 230-234, 236-238
Fishing tackle.....	31, 35, 37, 88, ill. 32, 70, 78, 79, 80, 82, 96, 97, 188
Flatfish (Flounders and Halibuts) Origin and growth of.....	1, 3, 17
Fleet, Fishing, near Customhouse Tower, Boston.....	ill. 16
Fleet, Oyster lying off Baltimore.....	ill. 221
Florida, Coast of.....	127, 130, 131, 135, 139, 140, 142, 159, 163, 173, 174, 187, 189, 194
Flounder family.....	1, 15, 27, 29, 38, 163, 184
Flunder, Summer (<i>Paralichthys dentatus</i>).....	1, 27, 38, 55, (color plate) 40
Flounder, Winter (<i>Pseudopleuronectes americanus</i>).....	1, 38, 55, (color plate) 40
Flying fish.....	8, 35, 150, 174
Fog, Summer.....	235-236
Foods of fishes.....	88-89, 174
Forbes, Professor S. A.....	88
Forked tails, Why fish have.....	173
Four-Eyed Fish (<i>Chaetodon capistratus</i>).....	(color plate) 177
Fraser River, British Columbia.....	199, 203, 209
French Angel-Fish (<i>Pomacanthus paru</i>).....	(color plate) 176
French Grunt.....	185
Fresh-water Drum (<i>Aplodinotus grunniens</i>).....	89, 107, 109, (color plate) 123
Frog culture.....	81, 88
Fur-seal, Herd of Alaskan.....	ill. 206
Fusaro, Lago: Italy.....	(legend) 218

G

Gar (<i>Mycteroperca microlepis</i>).....	139, (color plate) 146
Game fish.....	31, 33, 35, 36, 37, 131, 133, 135, 139, 140, 191, 193, ill. 32, 133, 136, 137
Ganges, Upper, River: India.....	(legend) 160
Gar, a fish-eating fish.....	89, 90, ill. 106
Gar Pike has lung-like air bladder.....	13
Georges Bank.....	9
German Carp, Fish misnamed.....	195
Giant Octopus (<i>Octopus punctatus</i>).....	187
Giant Sunfish, or Mola.....	130
Gilbert, Dr. Charles H.....	202
Gill nets.....	77
Gizzard-shad.....	89
Gloucester Harbor, Mass.....	228, ill. 227
Gobies, Gray.....	163
Golden Orfe.....	90
Goode, G. Brown.....	30
Gorge below Niagara Falls, Fishing in.....	ill. 83
Grand Banks.....	225
Grand Menan, New Brunswick.....	9
Gray Gobies.....	163
Gray Snapper (<i>Neomenis griseus</i>).....	171, ill. 141
Grayling a game fish.....	31
Great Albacore, Tuna known as.....	33
Great Lakes are reservoirs of fish food.....	77, 81, 195, ill. 90
Great South Bay, New York.....	183
Green Moray (<i>Lycodontis funebris</i>).....	163, 167, (color plate) 177
Green Turtle (<i>Chelonia mydas</i>).....	142, (color plate) 158
Grimsby, England, World's leading fishing port.....	27
Ground Sharks (<i>Carcharhinus</i>).....	174, 183
Grouper, Black (<i>Mycteroperca bonaci</i>).....	139, (color plate) 146
Grouper, Nassau (<i>Epinephelus striatus</i>).....	139, (color plate) 145
Grouper or Rock Fish family.....	130, 139, (color plates) 145-146
Grouper, Red (<i>Epinephelus morio</i>).....	139, (color plate) 145
Grunt, Blue Striped (<i>Haemulon sciurus</i>).....	185, (color plate) 181
Grunt family.....	139, 184-185, ill. 132, (color plate) 181
Grunt, Yellow.....	185, ill. 132, (color plate) 181
Gudger, E. W.....	30
Gulf of Mexico.....	103
Gulf of St. Lawrence Halibut.....	ill. 228
Gulf Stream.....	127, 131, 140, 142, 159, 163, 173, 187, 191

H

Haddock (<i>Melanogrammus aegilifinus</i>).....	8, 9, 17, 24, 29, 38, 229, (color plate) 39
Hake a food fish.....	27, 229

	Page
Halibut (<i>Hippoglossus hippoglossus</i>)	1, 7, 15, 55, 77, 229, ill. 228, (color plate) 41
Halibut industry	ill. 28, 230
"Ham and Eggs" from Chesapeake Bay: Menhaden	ill. 56
Hammerhead Shark	191
Hampton, Va., Oyster culture at	ill. 222
Handling Tuna, St. Margarets Bay, Nova Scotia	ill. 18
Harding, President Warren G.	71, 133
Hatcheries, Fish	203, 205, ill. 202
Hauling nets down to the sea	ill. 4
La Have Bank	9
Hawksbill Turtle (<i>Eretmochelys imbricata</i>)	142, 159, 191, (color plate) 158
Hearing, Fish's power of	11
Hermit Crabs	(legend) 151, ill. 138
Herrick, Dr. F. H.	19, 25
Herring (<i>Clupea harengus</i>)	7, 8, 9, 13, 15, 27, 61, 136, 163, 195, ill. 232, (color plate) 47
Herring, Branch	5
Herring-Hog	191, 193
Herring industry	ill. 12, 58
Herring prepared for smoking: Lockeport, Nova Scotia	ill. 12
Hermaphrodite, Some species are	130
Hickory Shad	9
Hind, Rock (<i>Epinephelus adscensionis</i>)	164-165, (color plate) 180
Hind, Spotted	165
Hogfish, Spanish or Lady-fish	ill. 170
Holothurian, Sea-cucumber or Sea-pudding is a	131
Horse Mackerel, Tuna known as	33
Housatonic River	24
Hubbards Cove, Nova Scotia	ill. 31
Hampton Roads	36
Hudson River	24, 36, 195
Humpback Salmon	199, 200, 201, 202, 209
Huxley	8

I

Ice, Fishing through hole in	ill. 86
Ichthyologists	9, 30, 164
Index, Wash., Scene near	ill. 80
Indian fishing with spear: Minnesota	ill. 82
Indian River Inlet, Fla.	35
Island of St. Pierre: Fishing industry	ill. 36

J

Jack, Amber (<i>Seriola dumerili</i>)	140, 183, ill. 185, 188, (color plate) 155
Jack family	130, 139-140
Jack, Yellow, or Runner (<i>Carnax ruber</i>)	140, (color plate) 155
Japanese Crab	159
Japanese oyster crop	ill. 215
Jewfish, Giant	164, ill. 167
Jones, John Paul	(legend) 227
Jones, William S.	35
Jordan, David Starr	27, 30
Jumna Canal and River, India	(legend) 160

K

Kamchatka Peninsula	195
Karluk River, Alaska	209
Key West, Fla.	139, 142, 187, 195
Killer Whale, The Great Wolf of the Sea	137, ill. 162
Killies eaten by Bluefish	36
King Salmon	195
Kingfish (<i>Menticirrhus saxatilis</i>)	37, 71, (color plate) 76
Kingfish (<i>Scomberomorus regalis</i>)	139, (color plate) 149
Kotcher, Com. Charles W.	189

L

Ladder, Fish: Cazadero Dam, Ore.	ill. 203
Lady-fish or Spanish Hogfish	ill. 170
Lago Fusaro, Italy	(legend) 218
La Gorce, John Oliver. Devil-Fishing in the Gulf Stream	187
La Gorce, John Oliver. Fish and Fisheries of Our North Atlantic Seaboard	1
Lake Avernus, Italy	(legend) 218
Lake Chautauqua Muskellunge (<i>Esox ohienensis</i>)	105-106, ill. 105, (color plate) 121
Lake, Medina, Texas	(legend) 84
Lake Michigan	88
Lake Sturgeon (<i>Acipenser rubicundus</i>)	104-105, (color plate) 120
Lake Trout (<i>Cristivomer namaycush</i>)	29, 99-100, (color plate) 117
Landing Giant Tuna Fish, Cape Breton Island, Nova Scotia	ill. 33
Landing Tuna, Hubbards Cove, Nova Scotia	ill. 31
Lantern, Oysters growing on old	ill. 218
Large-mouth Black Bass (<i>Micropterus salmoides</i>)	90, 95, ill. 84, (color plate) 112
Lawrence, James	(legend) 227
Leeward Islands	5

Leopard Shark	193
LIFE ON THE GRAND BANKS: AN ACCOUNT OF THE SAILOR-FISHERMEN WHO HARVEST THE SHOAL WATERS OF NORTH AMERICA'S EASTERN COASTS. By Frederick William Wallace	225
"Lion, Tiger and Elephant Trinity"	31
Loading Sardines: New Brunswick	ill. 20
Lobster, American (<i>Homarus americanus</i>)	15, 16-17, 19, 21, 67, 69, 159, (color plate) 54
Lobster carries its eggs, How	7, 25, 27, ill. 11
Lobster industry	24, 25, 27, ill. 13, 26, 67
Lobster meat, Canning	ill. 13
Lobster, Spiny or Crawfish (<i>Panulirus argus</i>)	159, (color plate) 153
Lockeport, Nova Scotia: Herring industry	ill. 12, 58
London Zoological Gardens	90
Long Island, N. Y.	27, 163, 216
Long-nosed Gar	90
Lumpfish a marketable fish	5, 229
Lunenburg, Nova Scotia	225, 228
Lung-fish, Australian	90

M

Mackerel (<i>Scomber scombrus</i>)	8, 9, 15, 27, 59, (color plate) 44
Mackerel Shark	173
Mackerel, Spanish (<i>Scomberomorus maculatus</i>)	139, (color plate) 149
McDougall, Kenneth, Estate of	ill. 89
McCloud River, Calif.	205
McCloud River Rainbow Trout (<i>Salmo irideus shasta</i>)	100, (color plate) 118
Madras (India) Fisheries Bureau	170
Maine, Coast of	24, 27
Man-eating Shark	173
Man-of-War, Portuguese (<i>Physalia arethusa</i>)	174, (color plate) 178
Mangrove Snapper	191
Margate Fish (<i>Haemulon album</i>)	139, (color plate) 148
Maritime Provinces of Canada	195, 228
Marlin or Spearfish (<i>Tetrapturus imperator</i>)	135, 183, (color plate) 157
Matching fingers for barrels of fish: "Mora"	ill. 24
Medina Lake, Texas	(legend) 84
Menhaden	8, 17, 27, 214
Menhaden industry	ill. 56
Merrimac River	24
Miami Aquarium, Miami Beach, Fla.	139, 159, 194, ill. 165, 184
Miami Beach, Fla.	33, 133, 139, 140, 162, 163, 189, 194, ill. 165, 184
Miami, Fla.	187, ill. 134, 161
Milt and eggs removed from fish for artificial propagation	205, ill. 34, 211
Minnows are food supply of larger fish	77, 89
Mississippi River system, Fish of	77, 79, 84, 87, 88, 89, 90, 195, ill. 94, 102
Mola, or Giant Sunfish	130
Mollusks	89, 213, 214, 216-217, 218-219, 222-224
Monk-fish a marketable fish	229
Moon Fish (<i>Selene vomer</i>)	136-137, (color plate) 147
"Mora": Finger matching game	ill. 24
Moray, Green (<i>Lycodontis funebris</i>)	163, 167, (color plate) 177
Mosquito Coast of Central America	142
Mountain of oyster shells	ill. 222
Mouse Fish, naturally protected from enemies	173, 174
Mowbray, Louis L.	170
Mowbray, Louis L. Certain Citizens of the Warm Sea	127
Mud Minnows a fish-eating fish	89
Mudfish, or Bowfin	89, 90
Mullet (<i>Mugil cephalus</i>)	35, 71, 195, (color plate) 75
Muskellunge (<i>Esox masquinongy</i>)	31, 89, 90, 105-106, ill. 103
Murayama, Hashime (Artist)	(color plates) 39-54, 72-76, 111-126, 143-158, 175-182
Muskellunge, Lake Chautauqua (<i>Esox ohienensis</i>)	105-106, ill. 105, (color plate) 121
Mussel industry	84, 87
Mussels	19, 29, 81, 84, 87, 89, 217
Mutton Fish (<i>Lutianus analis</i>)	139, 171, ill. 134, (color plate) 144

N

Nassau Grouper (<i>Epinephelus striatus</i>)	139, (color plate) 145
Naugatuck River, Conn.	24
Nekton, actively swimming animal life	130
Nets	76, ill. 4, 14, 18, 62, 64, 70, 207
New Brunswick, Loading Sardines at	ill. 20
New England, Coast of	27, 163, 195, 228
New England lobster fishery, Saving the	ill. 26
New Jersey, Coast of	24, 27, 163
New York Aquarium	90, 93, 171
New York Zoological Society	170
Newfoundland	228, 229, ill. 17
Newfoundland Banks	1, 195
Niagara Falls, Fishing below	ill. 83
Nichols, Dr. John T. Curious Inhabitants of the Gulf Stream	163

	Page
Nichols, Dr. John T.....	30
Nicola River, British Columbia.....	5
Nipigon River, Canada.....	ill. 88
Noises made by fish.....	35, 132, 184
<i>Nomeus</i> (fish) as decoy.....	174
North Atlantic fisheries.....	1, 27
North Sea, Sturgeon caught in.....	ill. 37
Northamptonshire, Eng., Aquarium at.....	90
Nova Scotia.....	225, 228, ill. 9, 12, 18, 31, 57, 58
Nova Scotia fisherman hauling in his net, A.....	ill. 2
Nurse Shark.....	191
Nushagak Bay, Alaska.....	211, 212
Nushagak River, Alaska.....	209, 211

O

Oceanic Bonitos.....	174
Octopus (<i>Octopus americanus</i>)....	187, ill. 165, (color plate) 156
Octopus, Giant (<i>Octopus punctatus</i>).....	187
Oilskins, Fishermen in.....	ill. 237
Ojibway Indian fishing: Minnesota.....	ill. 82
“Oldwench” nickname for Queen Trigger-Fish.....	(legend) 179
“Oldwife” nickname for Queen Trigger-Fish.....	(legend) 179
Orfe, Golden.....	90
OUR HERITAGE OF THE FRESH WATERS. By Charles Haskins Townsend.....	77
Oviparous Fishes.....	7
Oyster, Anatomy of the.....	ill. 214
Oyster crop, Japanese.....	ill. 215
Oyster encumbered with a mass of eggs of the Whelk... ill.	215
Oyster industry.....	24, 213-214, 216-219, 222-224, ill. 215, 217, 220-222
OYSTERS: A LEADING FISHERY PRODUCT. By Hugh M. Smith.....	213

P

Pacific Salmon (<i>Oncorhynchus</i>).....	91, 197, 198, 199, 200, 202, 203, ill. 210, 211
Packing Sardines.....	ill. 23
Parker, G. H.....	30
Parrot-Fish, Rainbow (<i>Pseudoscarrus guacamaia</i>).....	163, 164, (color plate) 182
Passaic River.....	35
Perch a food fish.....	77, 89
Perch, Pike- (<i>Stizostedion vitreum</i>).....	89, 109, 195, (color plate) 125
Perch, White (<i>Morone americana</i>)..	89, 96-97, (color plate) 115
Perch, Yellow (<i>Perca flavescens</i>).....	90, 109, ill. 96, (color plate) 124
Perry, Oliver Hazzard.....	(legend) 227
Peterson, Captain.....	189
Philadelphia, Pa.....	29, 35, 127
Pickrel, Eastern (<i>Esox reticulatus</i>).....	31, 89, 100-101, (color plate) 119
Pike (<i>Esox lucius</i>).....	31, 77, 89, 101, 104, (color plate) 119
Pike, Gar, has a lung-like air bladder.....	13
Pike-perch (<i>Stizostedion vitreum</i>).....	89, 109, 195, (color plate) 125
Pilgrim Fathers.....	(legend) 227
Pilot, Cow or Sergeant Major (<i>Abudefduf saxatilis</i>)....	164, 183, 184, (color plate) 182
Pilot-fish, Remoras erroneously called.....	183
Plankton, a minute mass of plant and animal life.....	25, 130
Planting fish.....	ill. 91, 107
Pollock (<i>Pollachius virens</i>).....	9, 27, 29, 37-38, 229, (color plate) 39
Pompano, a food fish.....	137
Porcupine Fish.....	166, ill. 170
Pork Fish (<i>Anisotremus virginicus</i>).....	164, (color plate) 175
Porpoises.....	173, 191, ill. 131, 135
Port Logan, Scotland.....	ill. 89
Porto Rico, Island of.....	170
Portuguese Man-of-War (<i>Physalia arethusa</i>).....	174, (color plate) 178
Potomac River.....	24, (legend) 221
Pound nets, Fish catching device.....	77
Predaceous fishes.....	183
Prehistoric fish, Remains of.....	27, ill. 7
PROMINENT SPECIES OF THE MIDDLE ATLANTIC COASTAL WATERS.....	69
Propagation of fishes, Artificial.....	25, 205, ill. 34, 91, 107
Protozoa, One-celled.....	27
Puffer or Swell-fish.....	166, 167, ill. 141
Puget Sound.....	199, 200, 201, 202, 213

Q

Queen Trigger-Fish (<i>Balistes vetula</i>).....	166, (color plate) 179
Quero Bank, off Nova Scotia.....	236
Quinnat Salmon.....	195, 199

R

Rainbow Parrot-Fish (<i>Pseudoscarrus guacamaia</i>).....	163, 164, (color plate) 182
---	-----------------------------

	Page
Rainbow Trout.....	ill. 85
Raritan River, N. J.....	35
Ray family, Member of.....	ill. 166
Red Grouper (<i>Epinephelus morio</i>).....	139, (color plate) 145
Red Salmon.....	199, 209
Red Snapper, a food fish.....	173
Red Tunny, Mystery about spawning grounds of.....	9
Remains of prehistoric fish.....	27, ill. 7
Remora, or Shark Sucker.....	183, ill. 68, (color plate) 180
Reptiles.....	142
Rescuing fish from a Mississippi River swamp.....	ill. 94
Retort cooking canned salmon.....	ill. 208
Rio Grande.....	195
River, India.....	(legend) 160
Rivers, American.....	5, 24, 35, 36, 77, 199, 203, 209, 221, ill. 80, 88, 203, 204
Rock Bass (<i>Ambloplites rupestris</i>).....	89, 90, 95-96, ill. 101, (color plate) 113
Rock Beauty (<i>Holacanthus tricolor</i>)..	164, 165, (color plate) 176
Rock Fish or Grouper family.....	(color plates) 145-146
Rock Hind (<i>Epinephelus adscensionis</i>).....	164-165, (color plate) 180
Rosefishes.....	7
Royal Sturgeon caught in North Sea.....	ill. 37
Runner or Yellow Jack (<i>Caranx ruber</i>)....	140, (color plate) 155
Russian fishermen.....	ill. 15
Russian names for Salmon.....	195
Russian Sterlets.....	90

S

Sacramento River, Calif.....	199, 203, 209
“Sacred Codfish” in the Boston State House.....	195, ill. 3
Sailboats.....	ill. 16, 26, 28, 33, 34, 66, 197, 221, 222, 226-229, 231-233, 236, 237
Sailfish (<i>Istiophorus nigricans</i>).....	130, 131, 133, 142, ill. 136, (color plate) 154
St. Dunstan’s Church, London: Blessing the fish of the sea ill.	6
St. John’s, Newfoundland, Cleaning fish at.....	ill. 17
St. Johns River, Fla.....	195
St. Margarets Bay, Nova Scotia.....	ill. 18
St. Pierre, Island of.....	236, ill. 36
SALMON, AMERICA’S MOST VALUABLE FISH. By Hugh M. Smith.....	195
Salmon, Atlantic (<i>Salmo salar</i>).....	5, 8, 23, 24, 25, 29, 30, 63, 91, (color plate) 50
Salmon, Chinook.....	5, 195, ill. 196, 201
Salmon eggs ready for shipment.....	ill. 200
Salmon industry.....	30, 199, 200, 201, 205, 209-212, ill. 30, 197, 200, 201, 207, 208
Salmon, Pacific (<i>Oncorhynchus</i>).....	91, 197, 198, 199, 200, 202, 203, ill. 210, 211
Salmon packed for shipping.....	ill. 30
San Francisco Bay.....	223, ill. 220
Sand Dab naturally protected from enemies.....	1, 15
Sand Flounder, pale-colored.....	184
Santa Catalina, Calif.....	33
Sardine industry.....	ill. 20, 23
Sardines, Tuna feeding on.....	ill. 169
Sargassum, Drifting.....	173
Saugatuck River, Conn.....	24
Sauger (<i>Stizostedion canadense</i>).....	109, (color plate) 125
Sawfish.....	7, ill. 130, 161
Sawfish, Female, taken alive.....	ill. 130
Schooners, Fishing.....	ill. 226, 229-233, 236-237
School of Porpoise migrating, A.....	ill. 135
Schroon River, Chestertown, N. Y.....	(legend) 96
Scotland.....	91, ill. 89
Sculpins are unmarketable.....	17, 235
Scup (<i>Stenotomus chrysops</i>).....	27, 63, (color plate) 49
Sea Bass (<i>Centropristes striatus</i>)....	37, 70, 164, (color plate) 73
Sea Catfish.....	137
Sea-cucumber, or Sea-pudding a Holothurian.....	131
Sea-drum, Sound made by.....	184
Sea-fan, Beautifully tinted.....	ill. 138
Sea Horse (<i>Hippocampus</i>).....	7, 165-166, (color plate) 178
Sea-pudding, or Sea-cucumber a Holothurian.....	131
Sea Robins.....	17
Sea Tiger, The—A Barracuda.....	134, 137, 139, 167, 170, ill. 134, 168, (color plate) 143
Sea Turtles.....	(color plate) 158
Sea-urchins protected by movable quills.....	ill. 138
Sergeant Major or Cow Pilot (<i>Abudefduf saxatilis</i>)..	164, 183, 184, (color plate) 182
Sex of fish.....	93
Shad (<i>Alosa sapidissima</i>).....	5, 8, 23, 24, 30, 59-60, 77, 195, (color plate) 46
Shark and his deadhead passenger.....	ill. 68
Shark Sucker (<i>Echeneis naucrates</i>)..	183, ill. 68, (color plate) 180
Sharks.....	7, 8, 137, 173, 174, 183, 191, 193
Sheepshead (<i>Archosargus probatocephalus</i>).....	31, 71, (color plate) 75
Shellfish.....	167
Shells, Mountain of oyster.....	ill. 222
Shiners are food for fish.....	77, 89
Shipping fish.....	29, ill. 30

	Page
Short-nosed Gar.....	90
Shoshone Falls, Idaho.....(legend)	97
Shrimps used as bait.....	35, 37, 174
Siam, Fighting fish of.....	15
Silver or Coho Salmon.....	199
Silver Hake known as Whiting.....(legend)	43
Silver King or Tarpon (<i>Tarpon atlanticus</i>).....	31, 35, 131, 133, 136, 183, 191, ill. 128, 133, 137, (color plate) 152
Silversides.....	89, 163
Skate.....	229, 235
Skeena River, British Columbia.....	209, ill. 207
Skippers on fishing schooners....	232, 233, 235, 236, 238, ill. 233
Skykomish River, Wash., Fishing in.....	ill. 80
Small-mouth Black Bass (<i>Micropterus dolomieu</i>).....	95, ill. 87, (color plate) 112
Smelt (<i>Osmerus mordax</i>).....	24, 65, (color plate) 52
Smith, Hugh M. Oysters: A Leading Fishery Product....	213
Smith, Hugh M. Salmon, America's Most Valuable Fish..	195
Smithsonian Institution, Washington, D. C.....	19, 27
Snails are fish food.....	89
Snake River.....(legend)	204
Snake River basin.....(legend)	97
Snapper family	164, 171, 173, 191, 195, ill. 141, (color plate) 144
Sockeye Salmon.....	199, 200
Soldato or Squirrel Fish (<i>Holocentrus ascensionis</i>).....	173, (color plate) 175
Sound, Croaking or grunting, made by Yellow Grunts	(legend) 132, 184
Sound made by Sea-drum.....	184
Sound made by Trumpet-fish.....	184
Sound made by Weakfish, or "Drummer".....	35
Spade Fish or White Angel (<i>Chaetodipterus faber</i>).....	163, (color plate) 176
Spanish Hogfish or Lady-fish.....	ill. 170
Spanish Mackerel (<i>Scomberomorus maculatus</i>).....	139, (color plate) 149
"Spat" or young oysters attached to oyster shell.....	ill. 217
Spawning habits of fish.....	5, 7, 199, 201-202
Spearfish or Marlin (<i>Tetrapturus imperator</i>).....	135, 183, (color plate) 157
SPECIES OF THE MIDDLE ATLANTIC COSTAL WATERS, PROM- INENT.....	69
Speckled Beauty, Three-pound (fish).....	ill. 88
Spiller net.....	ill. 18
Spiny Lobster or Crawfish (<i>Panulirus argus</i>)	159, (color plate) 153
Spotted Catfish (<i>Ictalurus punctatus</i>)..	93, 95, (color plate) 111
Spotted Hind.....	165
Spotted Sting Ray, or Whip Ray.....	216, 220, ill. 166
Spoonbill.....	89
Spring, or Tyee Salmon.....	195
Squeteague, Common (<i>Cynoscion regalis</i>).....	9, 24, 27, 31, 35, 69, 195, ill. 70, (color plate) 72
Squirrel Fish or Soldato (<i>Holocentrus ascensionis</i>).....	173, (color plate) 175
Squirrel Hake (<i>Urophycis chuss</i>).....	56, (color plate) 43
Stack of fish in Nova Scotia, A four-ton.....	ill. 57
Starfish.....	ill. 138, 216
Sterlets, Russian.....	90
Sticklebacks a fish-eating fish.....	5, 89
Sting Ray, Spotted, or Whip Ray.....	216, 220, ill. 166
Stockade, Oyster, San Francisco Bay.....	216, 223, ill. 220
Stone-cat a fish-eating fish.....	89
Stone, Livingstone.....	205
Striped Bass (<i>Roccus lineatus</i>).....	5, 24, 31, 35, 36, 69-70, 90, (color plate) 72
Sturgeon, Common (<i>Acipenser sturio</i>).....	5, 7, 55-56, 77, (color plate) 42
Sturgeon industry.....	ill. 10, 37
Sturgeon, Lake (<i>Acipenser rubicundus</i>)	104-105, (color plate) 120
Sturgeon, Largest caught in North Sea.....	ill. 37
Sucker, Shark (<i>Echeneis naucrates</i>)..	183, ill. 68, (color plate) 180
Suckers eat Mollusks.....	77, 89
Suckley, Dr. George	195
Summer Flounder (<i>Paralichthys dentatus</i>).....	1, 27, 38, 55, (color plate) 40
Sunfish.....	77, 89, 130, ill. 134
Surf Fishing.....	Frontispiece
Susquehanna River.....	24
"Swapping Whoppers" (fish stories).....	ill. 140
Swell-fish or Puffer.....	166, 167, ill. 141
Swordfish (<i>Xiphias gladius</i>).....	63, 65, ill. 66, (color plate) 51

T

Tackle, Fishing.	31, 35, 37, 88, ill. 32, 70, 78, 80, 82, 96, 97, 188
Tagging fish, Gentle art of.....	9, 11, ill. 8
Tarpon doing a fin spring.....	ill. 128
Tarpon or Silver King (<i>Tarpon atlanticus</i>).....	31, 35, 131, 133, 136, 183, 191, ill. 128, 133, 137, (color plate) 152
Taste, Sense of, lacking in fish.....	11
Tautog (<i>Tautoga onitis</i>).....	31, 61, (color plate) 48
Terrapin.....	88, 142
Thames River, Conn.....	24
Thompson, Capt. Charles H.....	162, 189, 191, 193
"The Tiger of the Sea," Barracuda called.....	134, 137-138, 167, 170, ill. 134, 168, (color plate) 143

	Page
Tiger Shark.....	191
Tilefish (<i>Lopholatilus chamaeleonticeps</i>).....	29, 65, 67, 127, 130, (color plate) 53
Top Minnows.....	89
Tortoise shell.....	142, 191
Towing an 800 pound Tuna to port.....	ill. 60
Townsend, Charles Haskins. Our Heritage of the Fresh Waters.....	77
Townsend, Charles Haskins.....	30
Trigger-Fish, Queen (<i>Balistes vetula</i>).....	166, (color plate) 179
"Trinity, Lion, Tiger and Elephant".....	31
Trout a food fish.....	77, 195
Trout, Brook (<i>Salvelinus fontinalis</i>)	97, 99, ill. 98, (color plate) 116
Trout, European.....	90
Trout, Lake (<i>Cristivomer namaycush</i>)	29, 99-100, (color plate) 117
Trout, McCloud River Rainbow (<i>Salmo irideus shasta</i>)....	100, (color plate) 118
Trout, Rainbow.....	ill. 85
Trout, Yellowstone (<i>Salmo lewisi</i>).....	ill. 79, 97
Trumpet-fish, Sound made by.....	184
Trunkfish, Buffalo (<i>Lactophrys trigonus</i>)	166-167, (color plate) 179
Tuna (<i>Thunnus thynnus</i>).....	29, 31, 33, 35, 59, ill. 18, 31, 33, 60, 169, (color plate) 45
Tuna, Allison's (<i>Thunnus allisoni</i>).....	140-142
Tuna industry.....	ill. 18, 31, 33, 60
Tunny, Red.....	9
Turtle Grass (<i>Zostera marina</i>).....(legend)	158
Turtle, Green (<i>Chelonia mydas</i>).....	142, (color plate) 158
Turtle, Hawksbill (<i>Eretmochelys imbricata</i>).....	142, 159, 191, (color plate) 158
Turtles.....	87, 88, 183
Turtles, Sea.....	142, (color plate) 158
Tyee, or Spring Salmon.....	195

U

U-boat, Barracuda resembles a.....	137
Unloading Halibut, Boston.....	ill. 28
Unloading Herring, Lockeport, Nova Scotia.....	ill. 58
U. S. Bureau of Fisheries, Work of.....	9, 11, 19, 25, 30, 79, 84, 203, 205, 210, 211, 223, 224, ill. 26, 34, 91

V

Vipan, Captain.....	90
Virginia Capes, Drying nets near.....	ill. 62
Viviparous Fishes.....	7

W

Wahoo, a game fish.....	131
Walbaum, Dr., German physician.....	195
Wall-eyed Pike.....	89
Wall, Fish scaling a seven-foot.....	ill. 160
Wallace, Frederick William. Life on the Grand Banks: An Account of the Sailor-Fishermen Who Harvest the Shoal Waters of North America's Eastern Coasts.....	225
Walton, Izaak.....	35, 81, 159
Weakfish, or Squeteague.....	9, 24, 27, 31, 35, 69, 195, ill. 70, (color plate) 72
Weir trap, Loading Sardines from.....	ill. 20
West Indian Conch (<i>Strombus gigantus</i>).....	130-131
West Indies.....	140, 142
Whales.....	8, 173, ill. 162
Whelk, Eggs of the, encumbering Oysters.....	ill. 215
Whip Ray, or Spotted Sting Ray.....	ill. 166
White Angel or Spade Fish (<i>Chactodipterus faber</i>).....	163, (color plate) 176
White Bass a fish-eating fish.....	89
White Perch (<i>Morone americana</i>)... ..	89, 96-97, (color plate) 115
Whitefish, Common (<i>Coregonus clupeiformis</i>).....	77, 90, 93, 106-107, 195, ill. 104, (color plate) 122
Whiting (<i>Merluccius bilinearis</i>).....	27, 57, 229, (color plate) 43
Willapa Bay, Wash.....	223
Williams, Stephen R.....	1
Winter fishing.....	ill. 86
Winter Flounder (<i>Pseudopleuronectes americanus</i>).....	1, 38, 55, (color plate) 40
Wolf-fish.....	229
Wolf of the Sea, Kilier Whale, the Great.....	137, ill. 162
Woman fishing.....	ill. 70
Wood River, Mass.....	211, 212
Wrasse changes color.....	183-184

Y

Yacht: L'Apache.....	189
Yellow Grunt.....	185, ill. 132, (color plate) 181
Yellow Jack, or Runner (<i>Caranx ruber</i>)... ..	140, (color plate) 155
Yellow Perch (<i>Perca flavescens</i>)..	90, 109, ill. 96, (color plate) 124
Yellow Tail (<i>Ocyurus chrysurus</i>).....	130, 173, (color plate) 181
Yellowstone Lake, Yellowstone National Park.....	ill. 79
Yellowstone Trout (<i>Salmo lewisi</i>).....	ll. 79, 97
Yukon River, Alaska.....	5, 199, 204

NATIONAL GEOGRAPHIC SOCIETY

GEOGRAPHIC ADMINISTRATION BUILDINGS
SIXTEENTH AND M STREETS NORTHWEST, WASHINGTON, D. C.

GILBERT GROSVENOR, President
JOHN OLIVER LA GORCE, Vice-President
JOHN JOY EDSON, Treasurer
BOYD TAYLOR, Assistant Treasurer

HENRY WHITE, Vice-President
O. P. AUSTIN, Secretary
GEO. W. HUTCHISON, Associate Secretary
EDWIN P. GROSVENOR, General Counsel

FREDERICK V. COVILLE, Chairman Committee on Research

EXECUTIVE STAFF OF THE NATIONAL GEOGRAPHIC MAGAZINE

GILBERT GROSVENOR, EDITOR

JOHN OLIVER LA GORCE, Associate Editor

WILLIAM J. SHOWALTER
Assistant Editor

RALPH A. GRAVES
Assistant Editor

FRANKLIN L. FISHER
Chief of Illustrations Division

J. R. HILDEBRAND, Chief of School Service

BOARD OF TRUSTEES

CHARLES J. BELL
President American Security and Trust
Company

JOHN JOY EDSON
Chairman of the Board, Washington
Loan & Trust Company

DAVID FAIRCHILD
In Charge of Agricultural Explorations,
U. S. Department of Agriculture

C. HART MERRIAM
Member National Academy of Sciences

O. P. AUSTIN
Statistician

GEORGE R. PUTNAM
Commissioner U. S. Bureau of Light-
houses

GEORGE SHIRAS, 3D
Formerly Member U. S. Congress,
Faunal Naturalist, and Wild-game
Photographer

E. LESTER JONES
Director U. S. Coast and Geodetic
Survey

WILLIAM HOWARD TAFT
Chief Justice of the United States

GRANT SQUIRES
Military Intelligence Division, General
Staff, New York

C. M. CHESTER
Rear Admiral U. S. Navy, Formerly
Supt. U. S. Naval Observatory

FREDERICK V. COVILLE
Botanist, U. S. Department of Agri-
culture

RUDOLPH KAUFFMANN
Managing Editor The Evening Star

JOHN FOOTE, M.D.
Professor of Pediatrics, Georgetown
University

S. N. D. NORTH
Formerly Director U. S. Bureau of
Census

JOHN OLIVER LA GORCE
Associate Editor National Geographic
Magazine

JOHN BARTON PAYNE
Chairman American Red Cross

J. HOWARD GORE
Professor Emeritus Mathematics, The
George Washington University

A. W. GREELY
Arctic Explorer, Major General U. S.
Army

GILBERT GROSVENOR
Editor of National Geographic Magazine

GEORGE OTIS SMITH
Director U. S. Geological Survey

O. H. TITTMANN
Formerly Superintendent U. S. Coast
and Geodetic Survey

HENRY WHITE
Member American Peace Commission,
Formerly U. S. Ambassador to France,
Italy, etc.

STEPHEN T. MATHER
Director National Park Service

ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

TO carry out the purposes for which it was founded thirty-six years ago, the National Geographic Society publishes the National Geographic Magazine. All receipts are invested in the Magazine itself or expended directly to promote geographic knowledge.

ARTICLES and photographs are desired. For material which the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage.

IMMEDIATELY after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. Four expeditions have followed and the extraordinary scientific data resultant given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures. As a result of The Society's discoveries this area has been created a National Monument by proclamation of the President of the United States.

AT an expense of over \$50,000 The Society sent a notable series of expeditions into Peru to investigate the traces of the Inca race. Their discoveries form a large

share of our knowledge of a civilization waning when Pizarro first set foot in Peru.

THE Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole.

NOT long ago The Society granted \$25,000, and in addition \$75,000 was given by individual members to the Government when the congressional appropriation for the purchase was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people.

THE Society is conducting extensive explorations and excavations in northwestern New Mexico, which was one of the most densely populated areas in North America before Columbus came, a region where prehistoric peoples lived in vast communal dwellings and whose customs, ceremonies, and name have been engulfed in an oblivion.

THE Society also is maintaining expeditions in the unknown area adjacent to the San Juan River in southeastern Utah, in Yunnan, Kweichow, and Kansu, China, at Carlsbad Caverns in New Mexico, probably the largest cave yet discovered in America, and at Cuicuilco, Mexico, where the relics of inhabitants of America 7,000 years ago are being revealed.

OTHER AUTHORITATIVE PUBLICATIONS

THE CAPITAL OF OUR COUNTRY

By CHARLES MOORE,
CHIEF JUSTICE WILLIAM HOWARD TAFT,
GILBERT GROSVENOR, J. R. HILDEBRAND,
and the late VISCOUNT JAMES BRYCE
16 full-page color plates, 118 black and white en-
gravings; 2 maps; 154 pages
Royal octavo (7 x 10 in.) Cloth, \$3.

THE VALLEY OF TEN THOUSAND SMOKES

By ROBERT F. GRIGGS
*Leader, Katmai-Alaska Expeditions of the National
Geographic Society*
262 engravings and color plates; 7 Special Maps;
350 pages
Royal octavo (7 x 10 in.) Cloth, \$3.

THE BOOK OF DOGS

Paintings by LOUIS AGASSIZ FUERTES
100 exceptional dog portraits in color; 27 half-
tones; 96 pages
Royal octavo (7 x 10 in.) Buckram, \$2.

FLAGS OF THE WORLD

By COMMANDER BYRON McCANDLESS, U. S. N., and
GILBERT GROSVENOR
1,200 flags in full colors; 300 insignia of American
armed forces; 142 pages
Royal octavo (7 x 10 in.) Buckram or Khaki, \$2.

All books postpaid in United States; foreign postage 25 cents additional

MAPS FOR WALL AND DESK USE

The Society also makes available its New Map of the United States (28 x 38 inches); New Map of North America (27 x 36 inches); Map of the New Europe (30 x 33 inches); New Map of Asia (28 x 36 inches); New Map of South America (25 x 35 inches); New Map of Africa (28 x 32 inches); New Map of the Countries of the Caribbean (23½ x 42 inches); and New Map of the World (27 x 40 inches), *paper, \$1 each; on map linen, \$1.50 each.* Also, Races of Europe Map (20 x 24 inches), *paper, 25 cents; linen, \$1;* Map of the Islands of the Pacific (18 x 24 inches), *paper, 50 cents; linen, \$1;* Map of the Western Theater of War (26 x 31 inches), *paper, 50 cents; linen, 75 cents;* Map of Mexico (1916) (19 x 28 inches), *paper, 25 cents; linen, 75 cents,* and Map of Alaska (1914) (15 x 20 inches), *paper, 50 cents.*

All Maps in Colors postpaid in United States; foreign postage 25 cents additional.

BOUND VOLUMES OF THE NATIONAL GEOGRAPHIC MAGAZINE

A limited number of bound volumes of THE GEOGRAPHIC are available, beginning with the year 1921; six numbers to the volume, two volumes to the year.
Bound in half morocco, \$5 per volume.

Postpaid in the United States; foreign postage 75 cents additional.

A Pamphlet descriptive of The Society's Panoramas
and Pictures suitable for framing sent upon request.

NATIONAL GEOGRAPHIC SOCIETY

HUBBARD MEMORIAL HALL

WASHINGTON, D. C., U. S. A.

SCENES FROM EVERY LAND

(Fourth Series)

By GILBERT GROSVENOR

200 full-page illustrations, 24 in 4 colors; 20,000
words of text

Royal octavo (7 x 10 in.) Cloth, \$2.

WILD ANIMALS OF NORTH AMERICA

By EDWARD W. NELSON

Paintings by LOUIS AGASSIZ FUERTES

127 full-color portraits; 86 photographs and track
sketches; 240 pages

Royal octavo (7 x 10 in.) Buckram, \$3.

THE STORY OF THE HORSE

By MAJOR GENERAL WILLIAM HARDING CARTER
24 color portraits by EDWARD HERBERT MINER;
60 engravings; 110 pages
Royal octavo (7 x 10 in.) Buckram

THE BOOK OF BIRDS

By HENRY W. HENSHAW

Paintings by LOUIS AGASSIZ FUERTES

250 subjects in full color; 58 other illustrations;
200 pages

Royal octavo (7 x 10 in.) Buckram, \$3.

H281 83





OCT 83

N. MANCHESTER,
INDIANA 46962

LIBRARY OF CONGRESS



0 005 465 365 7